# THE THIRD POWER KINK BOOK

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*A collection of short articles from POWER describing stunts which have proven valuable as time savers in Power Plant Work*


Compiled by the
Editorial Staff *of* POWER



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# PREFACE

Recent high material and labor costs and inability to get prompt deliveries at any price, have forced operating engineers as never before to develop short cuts and ingenious schemes for doing things in unconventional but efficient money-saving ways.

Many of these kinks, adopted perhaps as eleventh-hour measures, made good so emphatically in practice that they represent definite forward steps in the handling of vital power details, and as such deserve the careful study of every engineer and executive who wishes to lop off all unneccessary cost-corners and make his plant increasingly efficient.

This Book, the third of a famous and widely used series, has hundreds of just such kinks, gathered from all over the field, and contributed by ingenious men who have tried their ideas out in their own plants and found them worth passing on to others faced by similar difficulties.

The Third Power Kink Book is larger than those which have preceded it and every kink is new—never before published in book form. As in the earlier books, each kink is described in the words of its inventor, and practically every one of the three hundred kinks is accompanied by a chart or diagram that makes the subject matter doubly clear.

These kinks have all appeared from time to time in the weekly pages of *Power*, whose editors are in constant touch with power men the country over, and are republished in convenient book form to make them available for reference, for study, for guidance in meeting emergencies, and avoiding shut downs.

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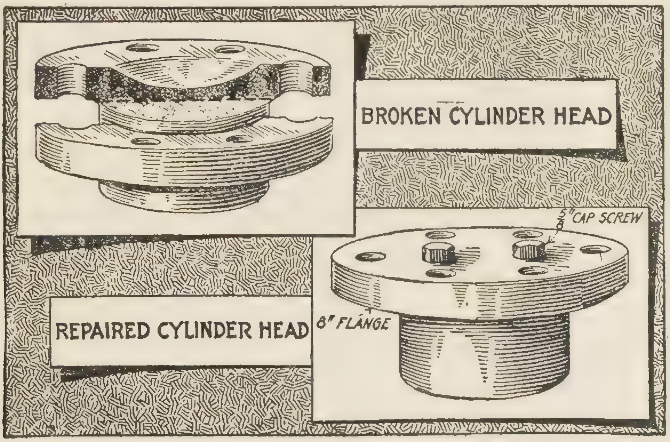
# THE THIRD POWER KINK BOOK

## *SECTION I*

## ENGINE-ROOM KINKS

### BROKEN CYLINDER HEAD REPAIR

THE head of a 5 x 5-in. steam engine cylinder operating a stoker blew out. A temporary repair was made as follows: The broken head was chipped along the line shown dotted, keeping the depth measurement as near as possible to that of the original head. This hub part was secured to an 8-in. blank flange, which happened to be the right size, with two $\frac{5}{8}$-in. capscrews, as shown in the illustration. In three hours the engine was ready to run.



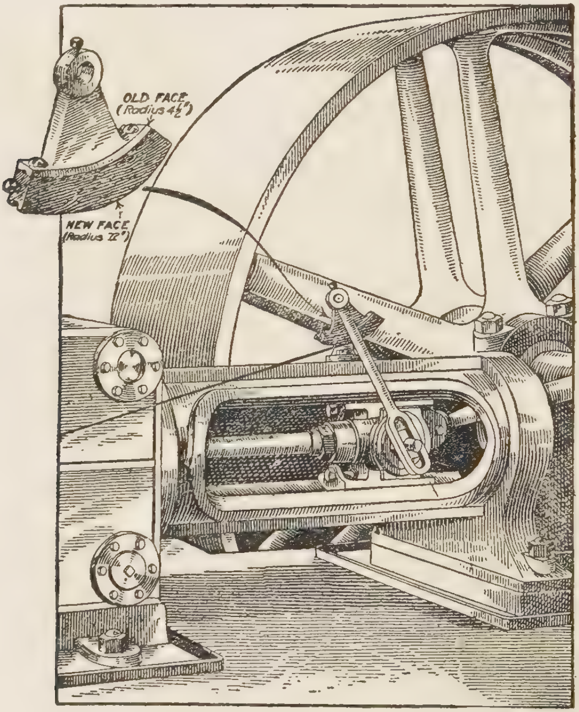

BLANK FLANGE IN PLACE OF CYLINDER HEAD

## CLICK IN CORLISS ENGINE

In case of clicking engine flywheel examine the rim for loose bolts. If any are found loose, remove and heat them and drive them back into place. After tightening, start the engine and the trouble will generally be overcome.

## ALTERING A REDUCING MOTION

Sometimes it is desirable to alter a reducing motion. In one instance the reducing motion gave a diagram only 2½ in. long, which was too short. Used the rule of proportion, 2½:4½::4:7.2 in. Thus the 2½-in. card was made from a reducing motion, the face of which was 4½ in. from the center point.




ALTERED REDUCING MOTION

A card say 4 in. long would require a reducing motion having a distance of 7.2 in. from the center to the face. To obtain the proper travel of the indicator drums, add a piece of wood as shown in the illustration. This will give a card exactly 4 in. long.

## BULL-RING REPAIR JOB

An engine gave trouble by steam blowing past the piston, due to the bull-ring being worn ¼ in. To repair it in a machine shop would cost about $300. The largest lathe in the factory had only a 12-in. swing. A drill press with a 30-in. table was among the shop equipment.

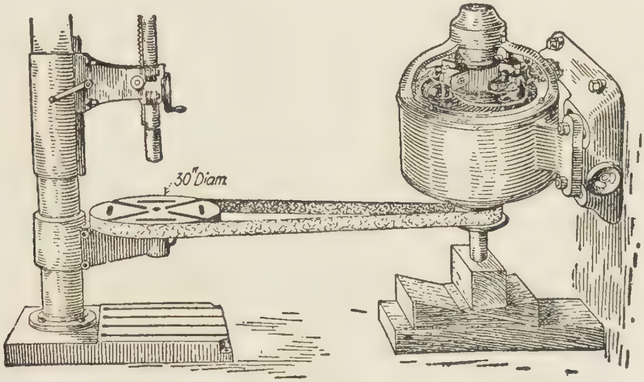



FIG. 1. EMERGENCY ARRANGEMENT OF MOTOR AND DRILL PRESS

The table was removed, cleaned and graphite put in the bearing so that it would run freely. An old motor with a flange pulley was lined up with the table. The oil was drained out of the motor bearings, and it was then secured to the wall by expansion bolts. The shaft was blocked up with wood and taper wedges from the floor. The motor and table

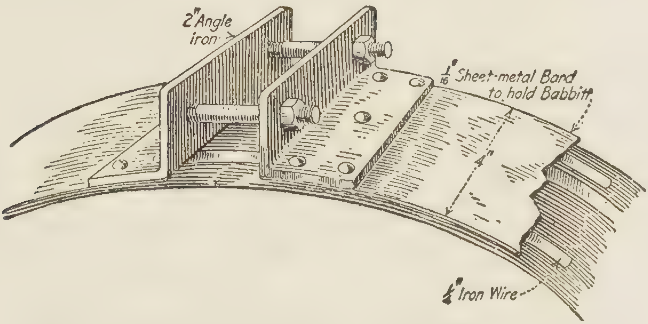



FIG. 2. SHEET-IRON BAND FOR BABBITTING BULL-RING

were connected by a 2-in. belt, Fig. 1, and a boring bar was placed in the drill-press spindle.

The bull-ring, which had been rebabbitted by pouring the metal inside a 4-in. wide sheet-iron band elevated by ¼-in. wire, Fig. 2, was then

secured in the drill-press table and, with the table revolving, was turned to the proper size.

## AN EMERGENCY ENGINE REPAIR

The main pillow block of an engine got so hot that the babbitt commenced to run and had to be rebabbitted.

The out-board end of the shaft could be jacked up, but conditions were such that the crank end had to be raised with a 3-ton tackle. The babbitt was chipped out and, allowing the shaft to rest in the outboard bearing, the crank end was set a little high above the center (about $^1/_{16}$ in.), so that after some months of wear it would be worn down to the center.

Having the shaft set for height, and not having time to take out the piston and crosshead to put a line through in the usual way, the

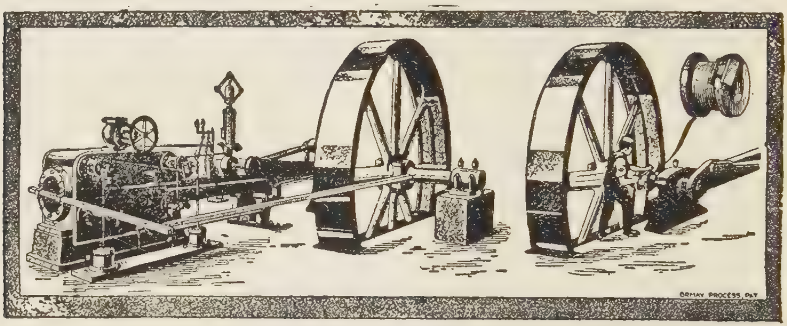


FIG. 1. HOW THE SHAFT OF THE ENGINE WAS ALIGNED    FIG. 2. SMOOTHING THE GOVERNOR BELT PULLEY

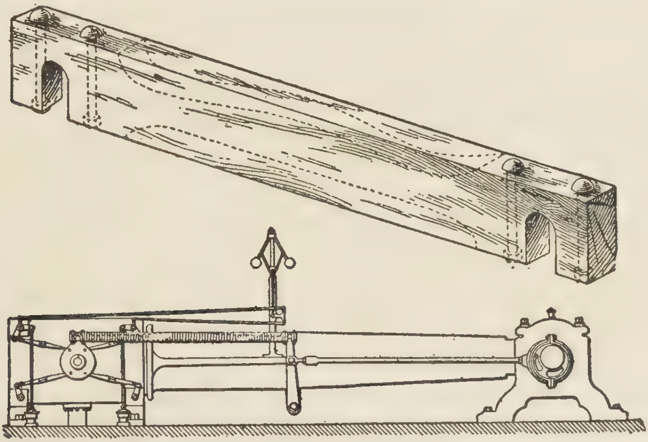
head-end cylinder head was removed and with a long straight-edge lightly clamped against the back end of the cylinder, and about central as to height and level, the shaft was set square by tramming from the straight-edge to the crankshaft, improvising an excellent tram by driving a round-headed nail in each end of a stick of the right length and about one inch square, first calipering the shaft to make sure that it was parallel (see Fig. 1). The bottom of the box was then poured, the shaft lifted out and the surplus babbit chipped off. Then the shaft was replaced and tested for alignment. The quarter brasses were poured and fitted, the cap being poured last.

While replacing the back cylinder-head and connecting-rod, the helpers let the tackle fall, and it struck the governor belt pulley and broke a big piece out of it. Some pieces of tin were fitted to the pulley and babbitt was poured to fill the vacancy where the piece was broken

out, Fig. 2. A built up wooden frame served as a tool rest and, using a carpenter's chisel as a hand tool, the engine was run on the throttle while the babbitt was turned down and smoothed up true.

## ENGINE REPAIR KEPT MINE PLANT RUNNING

The accompanying illustration shows an emergency repair to a Corliss engine. The rod transmitting motion between the rocker arm and the wristplate broke in such a way that it could not be repaired readily. The exact distance between the rocker arm and wristplate pin centers and the diameters of these pins was measured and this distance center to center was laid out accurately on an oak plank of suitable dimensions.



EMERGENCY REPAIR TO CORLISS ENGINE

First, holes of the diameter of the two pins were bored at the center points previously determined. The portion of the plank lying between these holes and one edge was then cut out, making a round-bottomed notch. The plank was then slipped over the pins on the valve gear and the engine started.

The plank-valve rod substitute was trimmed to the outline indicated by the dotted lines in the illustration. This rendered the plank much lighter, while leaving ample strength to work the wristplate. Two small carriage bolts were also added at either end to prevent splitting.

## HOME-MADE ENGINE SAFETY STOP

Engines driving auxiliary units in a power plant should be safeguarded by some kind of safety stop. Many of them are not so pro-

tected, but in one instance the engineer designed a home-made safety stop and applied it to two vertical engines directly connected to centrifugal pumps that were used for providing condenser circulating water.

Attached to the rim of the engine flywheel is a casting *A* in the body of which is a pin *B* held in place by a spring *C* under tension so that the outer end of the pin does not protrude beyond the edge of the casting when the flywheel is running at normal speed. The tension on the spring is such that should the engine speed up a certain number of revolutions above normal, the centrifugal force exerted on the pin would overcome the tension of the spring and the pin will project beyond the casting sufficiently to strike the end of the latch *D*, which is pivoted on a bolt on the angle iron *E*, that is securely bolted to the engine bed, as shown at *F*.

A dog *G* is secured to a shaft, and the projections *I* and *J* latch when the latch *D* is against the stop-pin *K*. The stop-pin *L* is to prevent the latch *D* from moving too far when struck and tripped by the pin *B*. The latch-pin *D* is 10 in. long, 3/8 in. wide, and is made with an easy curved surface on the face side. The angle iron supporting the latch *D* and dog *G* is of iron 2 1/2 in. wide and 3/8 in. thick.

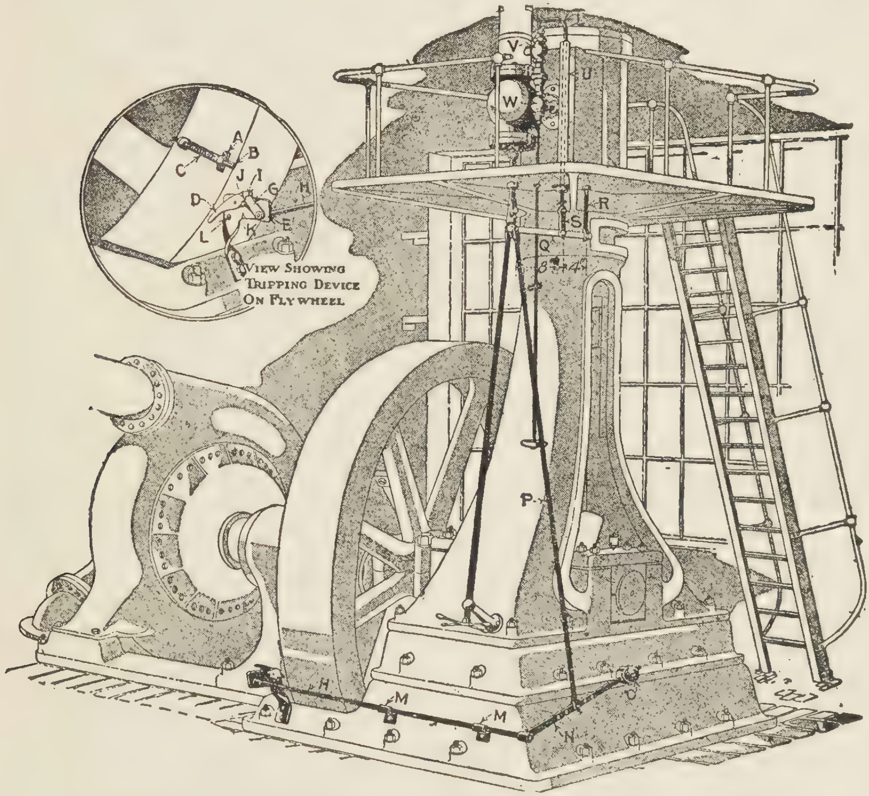
The 3/4-in. shaft *H* is supported at the opposite end from the angle iron *E* by two bearings *M* and carries 3/4-in. diameter weight lever *N*, on the end of which is 4-in. diameter weight *O*. This weight lever is drilled with several bolt holes, through one of which the 1/2-in. rod *P* is attached. This rod connects to one end of a rocker rod *U*, which is pivoted at the outer end to a 1/2-in. round stud *R*.

About midway of the arm *Q* a short link *S* is loosely pinned at one end and connects to a vertical rod *T*, which is supported by a hollow stand *U* that is secured to the engine grating platform.

The engine was originally piped to a 5-in. steam line with an angle valve connecting with a steam chest by a short nipple. This pipe was found to be too large for the service required, and a 1 1/2-in. angle valve *V* was therefore connected to the steam pipe above the 5-in. valve, and a second valve *W* of the same size, to act as a throttle valve, was connected to the first by a short nipple at one connection and the other to the 5-in. nipple connecting to the steam chest. The valve *W* was fitted with an extension valve stem convenient for the engineer to manipulate from the floor. With the latch *D* and the dog *G* latched, the valve *V* will be open, and with the valve *W* open the engine speed is controlled by the governor.

In operation the device works as follows: With the engine running at normal speed, the pin *B* does not project far enough beyond its housing to strike and trip the latch *D*, which is holding the dog *G* in

a locked position. In the locked position the weight *O* is in its highest plane and the valve *V* is consequently opened. Should the engine speed up beyond a predetermined number of revolutions, the pin *B* is thrown out to a position that causes it to strike the latch *D*, which trips the dog *G* and the weight *O* moves the lever in a downward direction, which motion is transmitted to the valve *V* through the rod *T*, thus



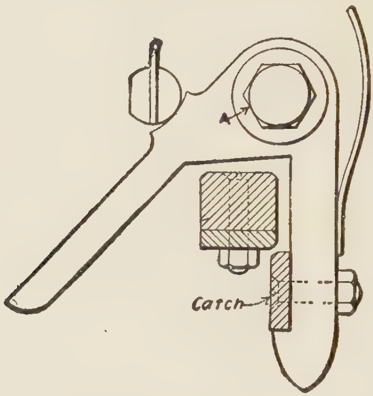

HOME-MADE ENGINE STOP AS APPLIED TO A VERTICAL ENGINE

shutting off the steam to the engine. The engine cannot be started again until the latch *D* and dog *G* have been engaged in the set position.

## LOOSE GRAB HOOK CAUSES TROUBLE

Trouble was had with the latch blocks on a Corliss valve gear, but the remedy proved very simple. It was necessary to change the catch plate on the head end every week or there would be trouble with the valve not picking up. It was found that the grab hook was loose and

would rattle. The bolt was removed and a shim put around it to make it fit snug in the hole, and after drawing the bolt up tight the grab hook




GRAB HOOK LOOSE AT PIVOT

was just snug without binding. This was the remedy for the worn catch plates.

## LOOSE PISTON CAUSED KNOCK

A drop-valve type engine developed a knock that became audible only when a certain speed was reached; when it was run single-acting

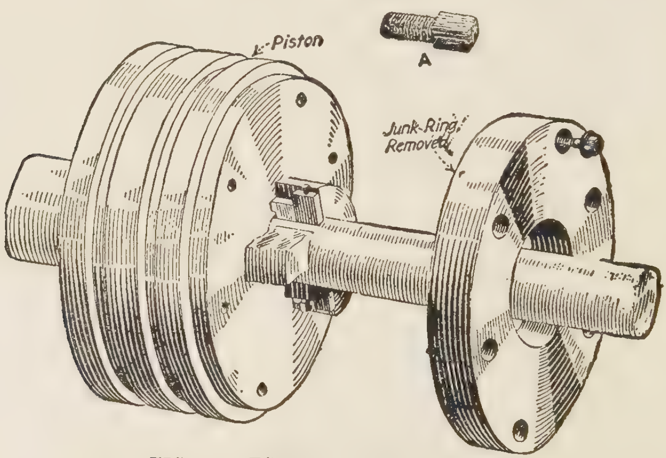



FIG. 1. DESIGN OF ENGINE PISTON

with steam shut off at the head end, the knock became inaudible. Upon taking the engine down for examination, it was found that the piston was constructed as shown in Fig. 1. It was held in position on the

piston rod by two taper wedges, which had worked a little loose, hence the knock.

The trouble was overcome by drilling and tapping the large ends of the wedges, afterward screwing into each one a brass stud, as shown at *A*, the plugs being made a little longer than required. In reassembling, the wedges are first driven in tight, then the brass studs are screwed in down to the head and filed off to the same diameter as the bore of the junk ring, the fastening on of the junk ring completing the job. The studs, being of brass, will expand under heat a little more than the cast-iron ring and the steel wedges, thus tending to keep everything tight.

On the same engine the drop-valve piston was held on the rod, as shown in Fig. 2, by two nuts and a cotter pin on the under side. The

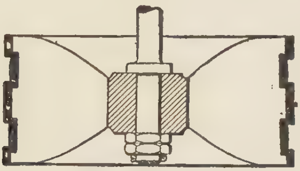


FIG. 2. FORMER DESIGN

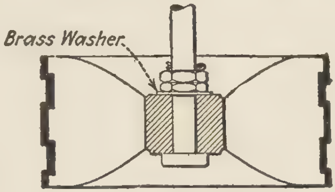



FIG. 3. AS CHANGED

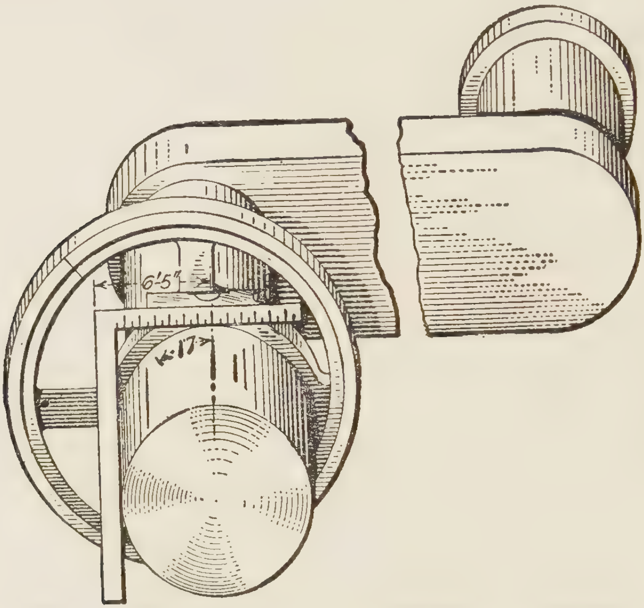
split pin sheared off on one and the nuts becoming loose, ultimately came off. This trouble was overcome by reboring the piston a little larger and changing the rod to the form shown in Fig. 3.

The use of brass washers are recommended where heat is used and slight tension is required, brass having a larger coefficient of expansion than cast iron or steel.

## MEASURING THE ANGLE OF ADVANCE OF AN ECCENTRIC

When measuring the angle of advance of an eccentric put the marks and measurements on the shaft instead of on the wheel. The first thing is to find the diameter of the shaft. Take a 13-in. shaft, then find the circumference by multiplying by 3.1416=40.8, which equals 360 degrees; the problem is to find the number of degrees the eccentric is ahead of a vertical line passing through the center of the shaft when the engine is on a center. Place a steel square with one blade against the shaft and the other blade horizontally over the shaft, by the use of a level on the blade, and in this way find the center, one-half the diameter of the shaft. Put a fine scratch mark at that point which is the center or 90 degrees ahead of the crank. The difference between this mark and one opposite the center of the throw of the eccentric,

measured with a steel tape, gives the advance of the eccentric which we will say was 1.7 in. This distance divided into the whole circumference goes 24 times ($40.8 \div 1.7 = 24$), so the eccentric is advanced $^1/_{24}$ of 360 deg., or $360 \div 24 = 15$ degrees.



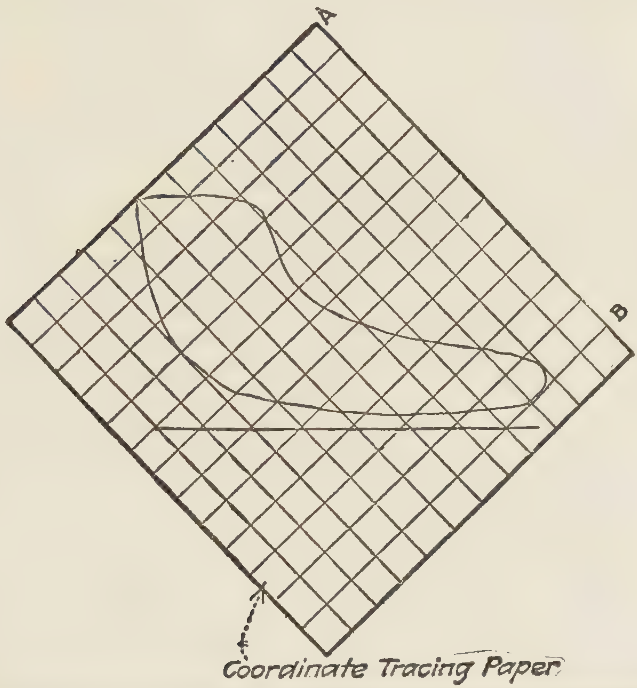

FINDING THE ADVANCE OF AN ECCENTRIC IN DEGREES

## MEASURING AN INDICATOR DIAGRAM

A simple method of measuring an indicator diagram is to take a piece of ordinary co-ordinate tracing paper, which is marked off in inches, usually in tenths of an inch. This paper is laid out very accurately and can be purchased at almost any stationery store.

Lay this tracing paper on top of the indicator card in such a way that any two lines—for example, lines *A* and *B*—fall tangent to the extreme ends of the diagram, as shown in the illustration. Then simply follow the usual instructions for performing the more laborious method. The difference is that the lines are already prepared and accurately spaced and drawn. These lines are arranged in squares, which makes it possible to estimate areas with the eye very accurately. Thus if the lines are one-tenth of an inch apart, the area of each small square is one one-hundredth of a square inch. Hence, if a half of a small square falls within the area of the diagram, the reader can estimate that much of the area with his eye with surprising accuracy.

For example, it may be found that the left end of the diagram includes portions of two squares and that each portion is approximately one-half of a hundredth of a square inch. The total area for the ordinate therefore would be, one hundredth of a square inch. The next ordinate may include two complete squares and a half of a square, making the total area 0.025 sq. in. In this way the columns or ordinates are




CO-ORDINATE PAPER USED TO MEASURE INDICATOR DIAGRAMS

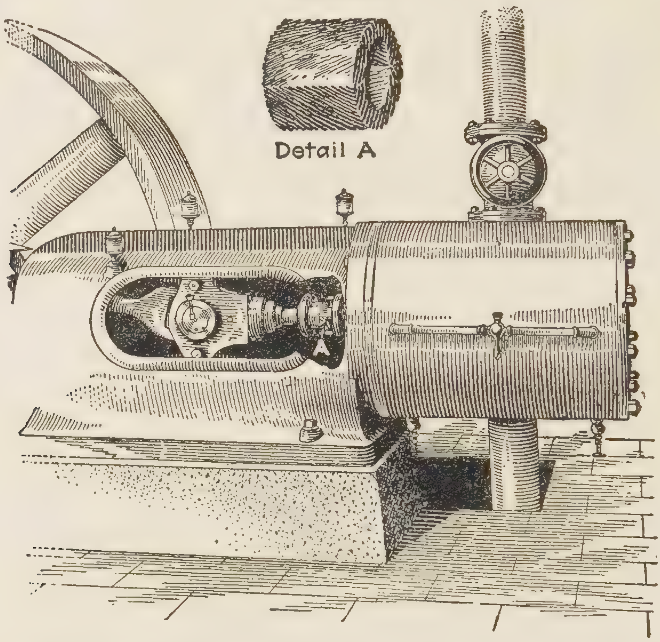
added from left to right, and the sum total of them all gives the area of the diagram. It is obvious that with squares laid out in tenths of an inch instead of eighths of an inch or sixteenths of an inch, the process is considerably simplified.

## PACKING A PISTON ROD

A method of packing piston rods with fibrous metallic packing is as follows:

Secure a wooden bushing, such as is used with wooden pulleys, which exactly fits the stuffing-box and rod, put in a small amount of packing at a time, place the bushing in the stuffing-box, jam it home with the gland, and repeat this until the stuffing-box is full. Then jam the gland

against the packing until it sets to conform with the shape of the gland. Frequently the distance between the oil splasher and the stuffing-box is very short. In such cases it will be necessary to saw the bushing off




USING WOODEN BUSHING WITH FIBROUS METALLIC PACKING

as the stuffing-box fills with packing. Do not attempt to jam the packing in with the gland, as it will not stay square in the stuffing-box.

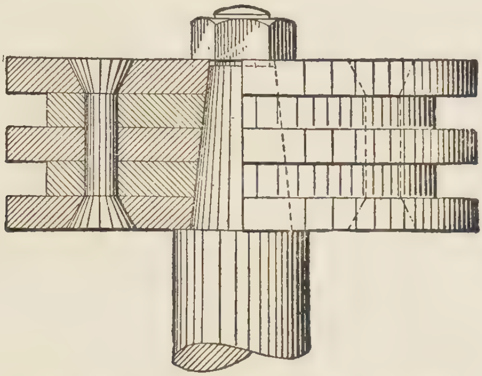
## PISTON MADE OF BOILER PLATE

A temporary repair to a small engine that was broken when the follower bolt came loose and made "small pieces" of the piston—in fact, too many to weld together—was made as follows. Five pieces of ½-in. boiler plate were cut out with the oxyacetylene torch and riveted together as shown on page 13. After finishing it in a lathe, it made a good piston.

## REFACING A SLIDE-VALVE SEAT

A method of refacing the seat on which an ordinary slide valve operates is to make a steel block *A* the size of the valve and drill a hole through it in which to fit the valve stem *B*. One side of this block is cut like a file. It is then tempered and fitted to the rod *B*. Then fit

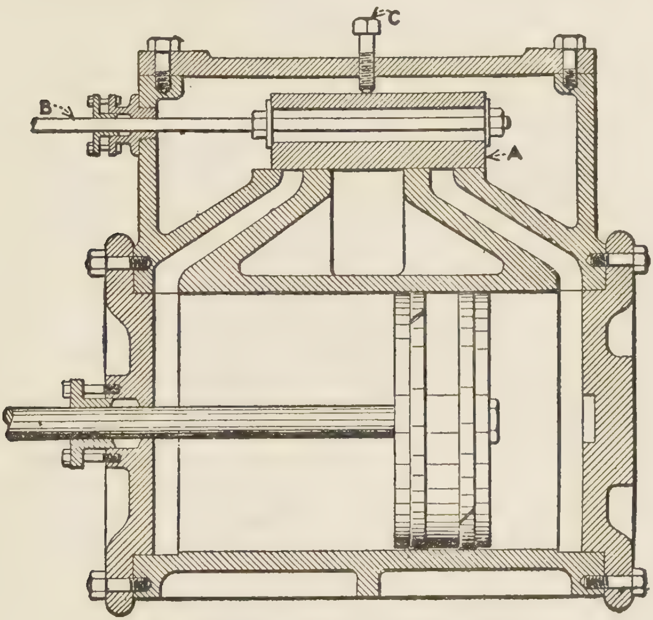
lengthwise across the steam chest another iron plate 2 in. wide and ½ in. thick, having a screw hole in which to insert the screw bolt *C*. This



BUILT-UP PISTON FOR SMALL ENGINE

plate is held in place by means of the steam-chest cover studs and nuts.

With everything in place and a slight pressure exerted on the plate



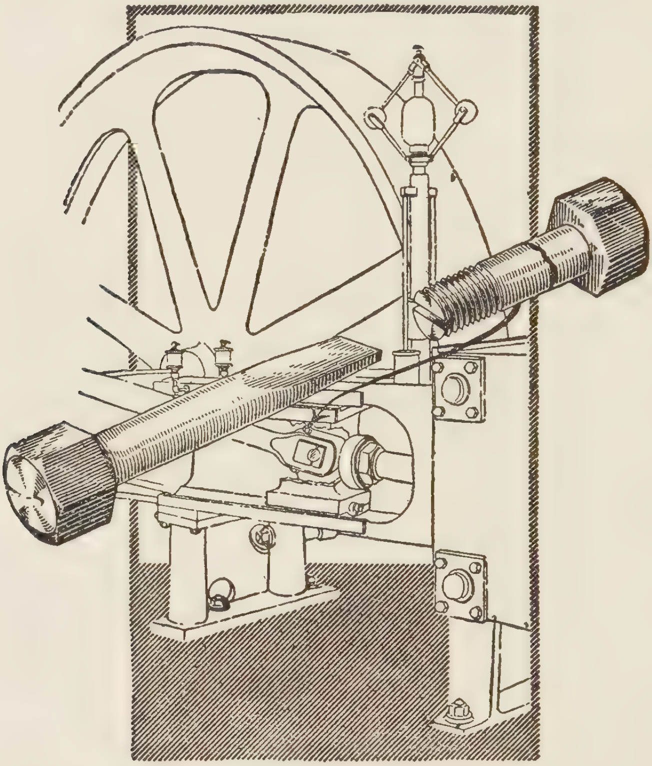

RIG FOR REFACING VALVE SEAT

*A* by the screw *C*, move the plate *A* back and forth by means of the rod *B* until the seat is true.

## REMOVING BROKEN ADJUSTING BOLTS

A handy tool can be made from a capscrew for the purpose of removing broken adjusting bolts from a wristpin adjusting wedge where a screwdriver cannot be used on account of the crosshead guide.

A screwdriver end is formed on one end of a capscrew and the head is left for turning with a wrench. This makes a tool just long enough



TOOL FOR REMOVING BROKEN ADJUSTING WEDGE BOLTS

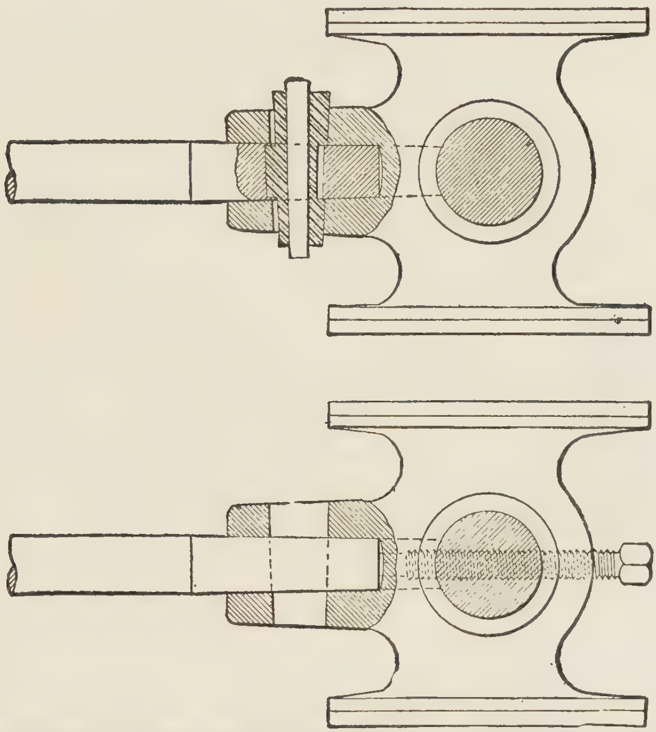
so that with the engine on the quarter-stroke, there is room to insert the tool. The adjusting-wedge bolt ends are slotted with a hacksaw before being put in place.

Before this tool was made it required an hour to put in a new bolt, because it was necessary to remove the wristpin from the crosshead in order to get the broken piece of bolt out of the adjusting wedge. Using this tool, it is possible for one man to do the job in from five to ten minutes.

## REMOVING A TAPERED PISTON FROM CROSSHEAD

Loosening a piston rod from a crosshead, when a tapered end and key is used, is sometimes quite an undertaking.

At times it is necessary to heat the crosshead before the taper can be started, and then a special key and followers or gibs are used, as



TWO METHODS EMPLOYED IN REMOVING A TAPERED PISTON ROD

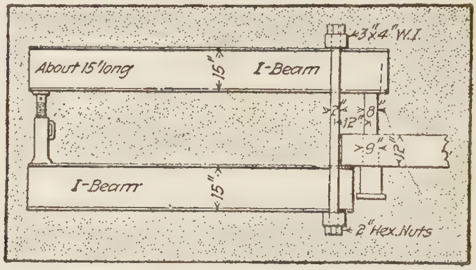
shown in the top view of the illustration. A fire of waste and oil may be built under a crosshead, of the double-guide type, and sledge the key with a 14-lb. hammer to start it.

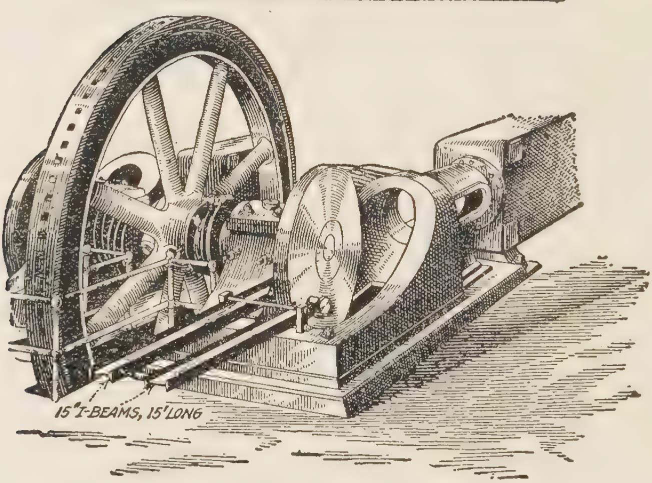
On small engines a false wristpin with a hole tapped for a setscrew was put in and the rod started with the jack so formed, as shown by the bottom view.

## RIG FOR REMOVING A CRANKPIN

An engine crankpin 9 in. in diameter and 12 in. long worked loose, but a 400-lb. battering ram had no effect on it in so far as knocking

it out was concerned. It was easily removed, however, with the application of the rig shown in the illustration. After its removal the old pin was built up with a welder and turned down to size.



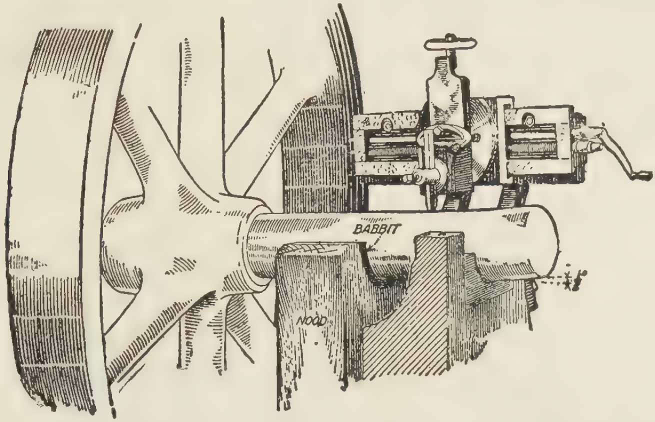

RIG FOR REMOVING CRANKPIN FROM AN ENGINE

After heating the disk red hot with a coke fire, the pin was forced back in place. It has since been running satisfactorily for four or five months.

## TRUING A BENT CRANKSHAFT ON A CROSS-COMPOUND ENGINE

A 10-in. crankshaft was repaired as follows: As the shaft was bent in the bearing, the crank disk was removed and a temporary bearing put in between the flywheel and the bent end. The quarter boxes were then removed, leaving the shaft to run in the temporary bearing. Next, a tool for turning off the bent part was rigged up; the cross-rail of a small planer was strapped to the engine bed about as shown in the illustration. The engine was then started, running from the high-pressure

cylinder, and the bearing part of the shaft was turned until it was true. Next, the outer end was turned for the crank disk until it was like-




PLANER CROSSHEAD WAS USED TO TRUE BENT CRANKSHAFT

wise true. The quarter boxes were then rebabbitted to fit the smaller diameter of the crankshaft, after which a sleeve was machined to fit on the end of shaft in order that the crank disk could again be pressed on.

## TURBINE BLADING REPAIR

A repair to the blading of a turbine that drove a pump consisted of welding Tobin-bronze sections onto the blades at the point where the steam strikes the blade which had become worn by the action of wet steam.

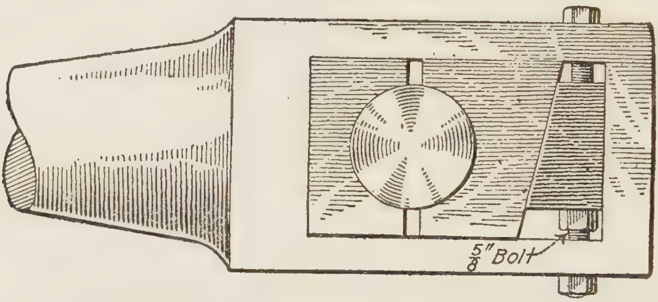
The worn places were about $\frac{1}{4}$ in. deep and $\frac{3}{8}$ in. long and were filled in and then dressed down by hand to conform to the shape of the blade.


Only one or two blades in a place were done at a time, the wheel being turned to a new position to avoid undue heating and consequent warping of the wheel.

After the job was completed, the wheel and shaft were placed on balancing ways, but the wheel balanced so well that nothing was done to it to improve the balance.

## USES A SINGLE WEDGE BOLT

Trouble was had with wedge bolt breaking off below the wedge. As a remedy the $3/4$-in. bolt was removed and a $5/8$-in. bolt put in with a nut under the wedge, as shown in the illustration. This overcame the




THROUGH BOLT REPLACES TWO CAPSCREWS

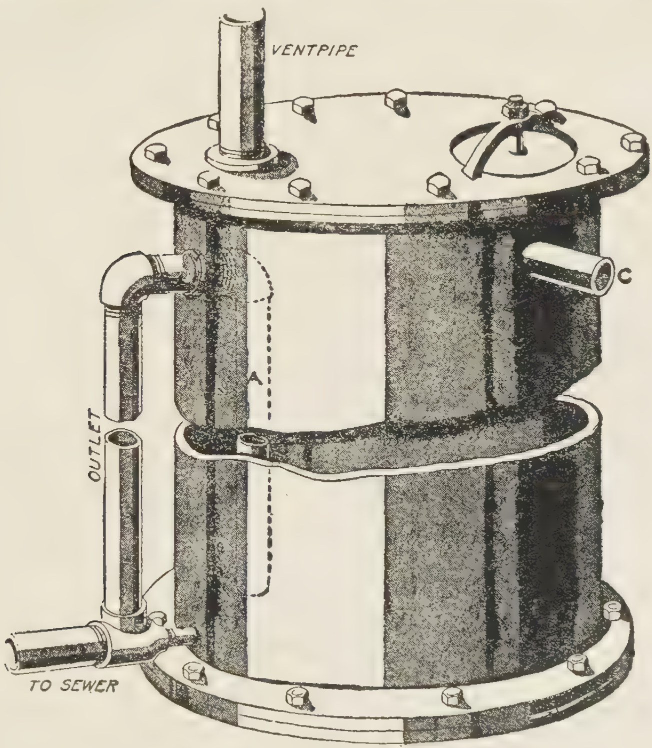
trouble and the bolt makes a better and safer job than the commonly used capscrew, and it does not loosen up as does the ordinary type of bolt.

*SECTION II*

# BOILER-ROOM KINKS

## BLOWOFF-TANK POINTERS

MANY city ordinances require that a blowout tank of approved design be connected between the boiler and the sewer, to prevent a



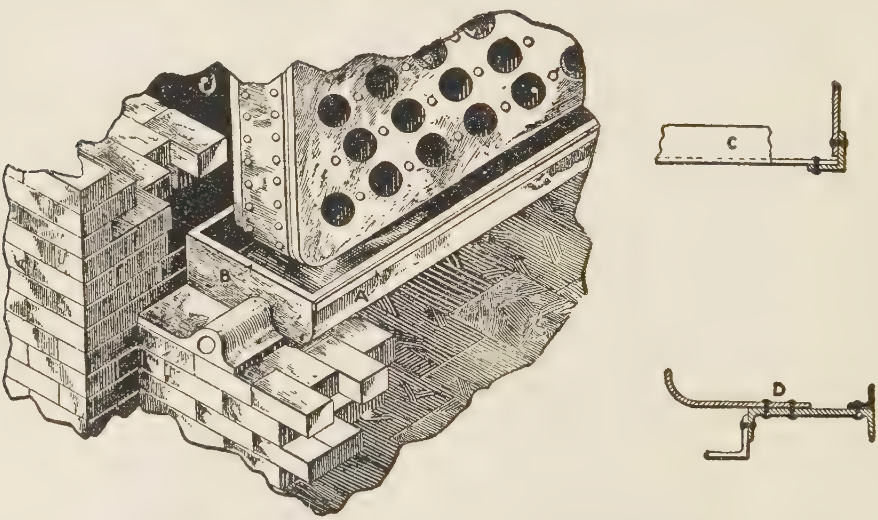

BOILER BLOWDOWN TANK

great quantity of steam reaching and injuring the sewer. With a properly designed blowoff tank, the steam and water will be separated to a large extent, and when all the outlet pipes from the tank are of

large diameter and free from obstructions, there is little or no pressure on the tank at any time. It is good practice to have blowoff tanks strong enough to withstand full boiler pressure; in fact, they should be built along the same lines as the boilers. The illustration shows a design of piping sometimes used, the inlet pipe being located at *C*, and the small ($1\frac{1}{4}$-in.) drain outlet connecting the outlet pipe to the bottom of the tank is a direct drain, although it is sometimes omitted, the idea being that the siphon will drain the tank. This small drain pipe should be used in every case, for when the blowoff valve has been open for a few seconds, the end of the small drain will be submerged and the tank will gradually fill and overflow through *A*. Suitable top and bottom cleanout holes should be provided.

## BOILER WATER-LEG DRIP PAN

In stoker-fired boilers where the furnace extends forward of the front water leg and the boilers are of the horizontal water-tube type,




APPLICATION OF DRIP PAN TO BOILER WATER LEG

considerable damage is done to the special arch and furnace tile, also to the stoker mechanism, by the drip of water, principally from the handhole plates.

The illustration shows a design of pan that has eliminated this trouble. The pan is cast in one piece and is of such dimensions as to extend the full length of the water leg and wide enough to extend 2 in. past the rear sheet to catch the drip at the expanded joint of the tubes; the front is curved up to meet the doors, and a $\frac{1}{4}$-in. projecting strip is provided for a joint *A*.

The side sheets of the front, which carry the door hinges, are fitted to the top edge of the pan *B;* and extension is provided for the support on the side walls, and this carries a $3\frac{1}{2}$-in. diameter boss tapped for a $1\frac{1}{2}$-in. pipe into the bottom of the pan; the end of this boss is flush with the side walls and is piped to the sewer.

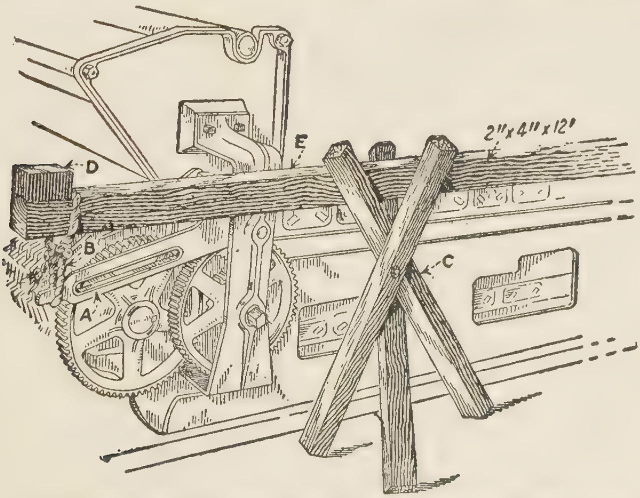
This pipe is large enough to carry a flood of water such as occurs when cleaning out or when the pressure is released on all the handhole gaskets at once, as when a boiler is taken off the line. When the boiler is in service, the temperature at this point is such as to evaporate all minor leaks if the pan is tight.

The sketch *C* shows the usual method of providing for this leak where the drip pan is made up of channels and angles and forms a part of the door frame. Bolts are generally used to permit adjustment of the parts in erecting, and the water leaks through the bolt holes and also through the side-sheet joint, which is below the bottom of the water leg.

The cast-iron pan has lugs projecting from the bottom to carry the stoker cover angles; these dispense with the angle iron *D*.

## CARRYING THE LOAD WITHOUT STOKER SHAFTING

In one instance the stoker shafting was damaged badly. Chain-grate stokers were used. In order to keep the plant running the appa-



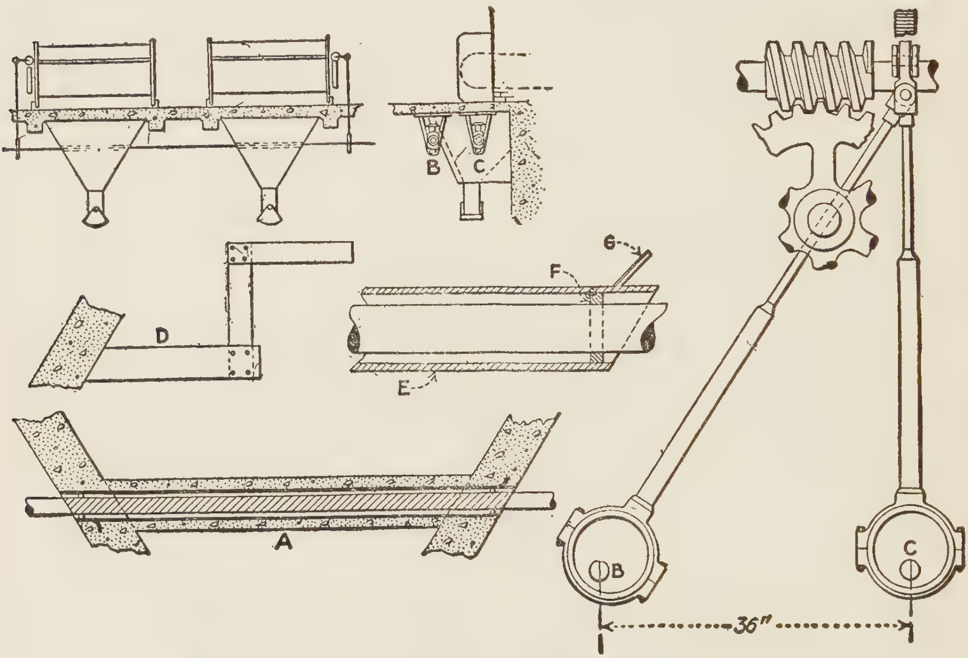

HOW THE STOKERS WERE OPERATED UNDER AN EMERGENCY

ratus shown in the illustration was made from 2 x 4-in. timber. *A* is the lever on the stoker, *B* is a rope, *C* is a three-legged sawbuck, *D* is a

balancing weight of firebricks, *E* is a 2 x 4-in. by 12-ft. stick for a lever. One man can sit on a box and run a stoker for two hours at a time if necessary.

## CHANGING A STOKER LINESHAFT

Where a lineshaft is used for driving chain-grate stokers, as is usually the case where one or more batteries of boilers are equipped with stokers, its location becomes a problem, especially where the design includes a siftings hopper for discharging into a chain conveyor.




DETAILS OF CHANGES MADE IN STOKER-SHAFT ARRANGEMENT

The objection to running the shaft directly through the siftings hopper is chiefly the deteriorating effect of the siftings on the steel shaft, and the waste of siftings through the lineshaft holes in the sides of the hopper. The figure *A* shows a method employed when changing the shaft from the outside position *B* to the position *C*.

The device *D* was made of wood and was used to lay off the holes in the ash-hopper sides and, when held against the tunnel ceiling, gave the true elevation for all holes measuring the distance from the tunnel wall.

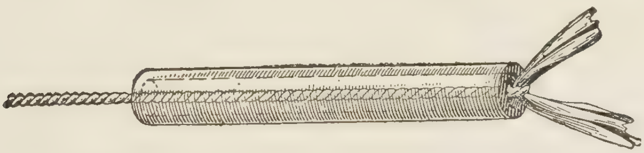
Eight pieces of 3-in. pipe *E* were sawed to a length equal to the width of the hopper and beveled as shown, and into each end of these was driven a babbitt collar *F*, bored to a running fit on the shaft.

The length of shaft was then taken down and the hangers moved to the new location between the hoppers. Two of the pipes $E$ were then slipped over the shaft, which was then pushed through the holes cut into the hopper sides, also slipping the eccentrics on where necessary. The shaft was then leveled and grouted in as shown at $A$. Wire screen was used to give the grout a bond on the pipe.

The slivers $G$ were sawed into and bent back on the pipe ends to prevent the babbitt collars $F$ from turning the pipes $E$. The object of the collars is to hold the shaft central of the pipes while the latter are being grouted in; they may be neglected after starting. It will be evident that in lining and leveling the shaft, the pipe, on account of the collars, will move with the shaft so that the holes in the hopper sides must be cut larger than the pipes. In this case a 4-in. diameter hole was cut for $3\frac{1}{2}$-in. outside diameter pipe. These and also the hanger-bolt holes were cut before the shaft was changed and while the boilers were in service so that the shaft could be moved in the least possible time. The new location puts the eccentric directly under the drive, and deterioration and siftings waste are taken care of.

## CLEANING GAGE-GLASSES

The matter of keeping gage-glasses clean is of great importance because otherwise it is quite possible to misjudge water levels. If the cause of the clouding is oil, it can be readily removed with chloro-



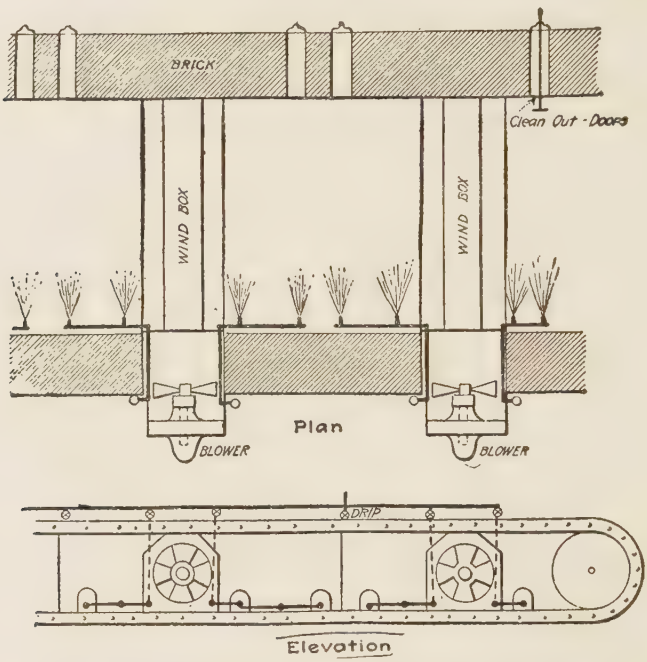
AVOIDING INJURING GAGE-GLASS WHILE CLEANING

form or other solvent. One of the most important points to bear in mind in cleaning gage-glasses, especially those used under high pressure, is to avoid scratching them with some sharp implement, such as a wire. Therefore, wood should be used to carry the wiper or, better still, a small piece of chloroform-soaked rag can be tied to the end of a piece of cord, dropped through the glass, and used to pull the rag through. Carelessness in cleaning or inserting glasses is the cause of a great many "mysterious" breaks. Care should also be taken in replacing glasses to see that they are not left in a strained position and that good live packing is used to permit expansion and contraction.

## CLEARING WINDBOXES OF SIFTINGS

The illustration shows how, by the use of steam jets, coal siftings may be cleaned out of the wind compartments of a chain-grate stoker when burning small anthracite.

The main steam line is 3/4 in., with nozzles reduced to 3/8 in. The main valve is kept closed and the drip valve open when the jets are not in use, to make sure that no water drips under the grates. When being put into operation, the drip valve is kept open until all water




STEAM JETS USED TO CLEAR STOKER WINDBOXES

is blown out of the piping, then the compartments are blown one at a time for about one minute and thoroughly cleaned. A short-handled hoe is used to remove the siftings from near the cleanout door.

By providing for this system when the boiler is being bricked in, the piping could be more direct, thereby saving considerable work and cost. With very small anthracite the compartments are cleaned once a day, but with larger sizes every other day is sufficient. Too much dirt should not be allowed to accumulate before blowing, and the steam line should be kept thoroughly drained to avoid wetting the mass so it cannot be blown out.

## GROUND CAUSED BOILERS PITTING

The boilers in a plant, in constant use for over ten years, had never shown the slightest evidence of internal pitting or corrosion. Suddenly they began to pit. At about the same time it was noticed that the storage battery supplying current for the house-telephone system and electric bells was failing; that is, required much more frequent charging to maintain it at the proper strength. The battery seemed to be in fairly good condition. A ground was suspected in the wiring and the trouble was finally located in an underground metal conduit in which were three twisted telephone pairs. When the wires were pulled from the conduit it was found that the insulation on all of them was water-soaked and rotten and the conduit corroded through in many places. A new conduit and new wires ended the battery trouble and also the pitting in the boilers.

## GUIDE FOR TUBE CLEANER

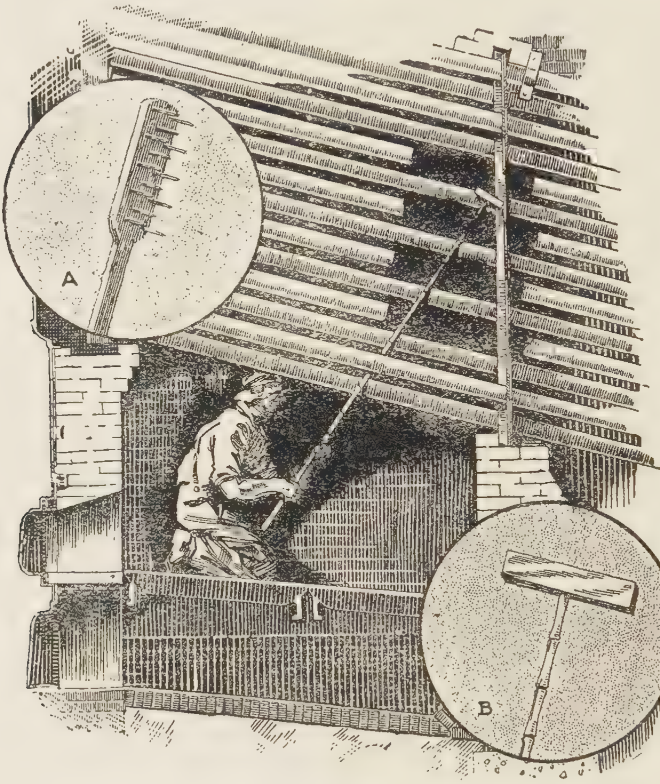
When turbining a water-tube boiler it is necessary to put one hand through an opening in the handhole plate to keep the cutter wheels together when entering the cleaner in a tube. A way to avoid the work of guiding the cleaner by hand is to use a piece of sheet iron shaped into a half-circle, the length being sufficient to project from the handhole plate a short distance into the tube. The outer end is flanged over and guides the cleaner into the tube and prevents the wear of the hose on the sharp edges of the handholes.

## HOME-MADE BAFFLE-WALL MIXTURE

A good mixture for protecting boiler baffles is made up as follows: About 200 lb. of clinkers that are thoroughly burned and show symptoms of having been heated to the melting point are crushed to a size not larger than rice coal. Then about 100 lb. of dry sand is thoroughly mixed with the ground clinker. Next obtain 50 lb. of glass and put it into a box and powder it as finely as possible. This is then mixed with the sand and cinders, after which 50 lb. of good quality portland cement is added, and after being thoroughly mixed about 25 lb. of fine dry asbestos is added. The batch is turned over and over until the materials are thoroughly mixed in a dry state.

When ready to apply the mixture, a stick of ¾-in. stock as shown at *A* is obtained, in the head of which No. 10 nails are driven about two

inches apart all the way through. The mixture is then wet just enough to make a stiff paste and a wad placed on the nails, run up between the tubes and slapped into place, and the operation repeated until the job is finished. After a portion of the baffle is covered use a tool made of a block of wood 2 in. wide, 5 in. long and 2 in. thick, having a handle



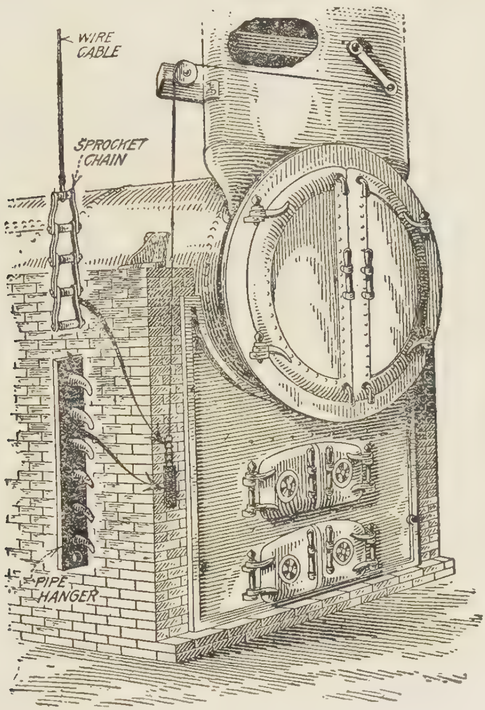

APPLYING THE BAFFLE MIXTURE

about 3 ft. long, as shown at *B*. A bamboo fishpole makes a good handle. This is passed up between the tubes and used to hammer the mixture in tight and of a smooth and uniform thickness.

## HAND DAMPER REGULATION

A convenient method of adjusting a hand-regulated damper is to use a piece of sixcoil pipe hanger. The boiler front is tapped for two ⅜-in. capscrews at a convenient point, and the hanger is screwed in place inverted, as shown in the illustration.

A wire rope is run from the damper to a small pulley and a few links of sprocket chain or a metal ring attached to the loose end of the rope. In some cases the damper shaft is not in the center and the damper will close itself when the rope is unhooked. Where the shaft is in the center of the damper, a weight on the end of the lever will close the damper when the cable is loosened. The various hooks permit of a wide range of control from closed to wideopen position.




A DAMPER CONTROL

## KEEPING EXPLOSION DOORS TIGHT

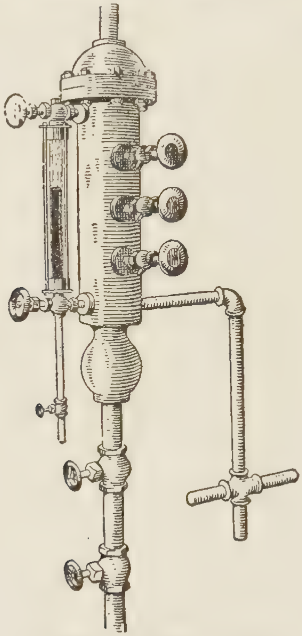
Explosion doors on boiler settings frequently give considerable trouble from air leaking in between the door and the frame. It is poor policy to go to the expense of applying a protective covering to the settings for the purpose of preventing the infiltration of air and then to allow the doors to pass large quantities directly into the furnace.

With doors hinged at the top, the frame extends from the wall several inches at the bottom, the door resting upon a packing ring laid into the frame, but it is difficult to keep this joint tight. To remedy this

remove the ½-in. pin from the hinge and replace it with a ⅜-in. one, which allows the door to adjust itself to the packing ring. This is not possible when the door is held rigid by a tight-fitting hinge.

## PLUGS IN WATER-COLUMN CONNECTIONS

Brass plugs in water-column connections may be arranged as shown. Remove the plugs when washing out the boilers. It will be observed



WATER COLUMN PIPING

that there are two globe valves in the water-column blow-off, so that if one gets to leaking the second valve will hold tight.

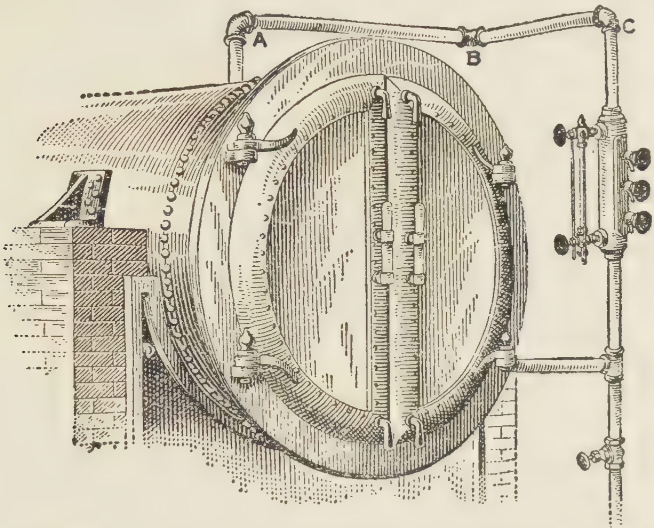
## POINTERS ON THE CARE OF GAGE-GLASSES

Perhaps a little more on the subject of breaking new gage-glasses may prove acceptable. At the first opportunity take out and clean the fittings thoroughly, being careful when replacing them to get them fairly in line.

Use a good quality of glass and soft-rubber rings, just set up the nut "hand-tight." Open the upper valve first and let the steam blow gently through the drain-cock until the glass is about the same temperature as the water in the boiler. Then open the bottom valve slowly before shutting off the drain-cock.

## POCKET IN STEAM CONNECTION TO WATER COLUMN

A new horizontal-tubular boiler had its water column connected as shown in the illustration. The pipe *ABC* dipped about 2 in. at *B*, forming a pocket or trap. When the water was at the level of the lower gage water appeared when either of the upper cocks was tried.




WATER SEAL IN STEAM CONNECTION TO WATER COLUMN

Steam would appear for an instant and then water. Opening these cocks caused a slight reduction in the pressure in the column and a consequent rise of water in the column. The fire was drawn and the pipe changed to eliminate the pocket at *B*, and the trouble was completely overcome.

## PREVENTING EXPLOSIONS IN WASTE-HEAT BOILER SETTINGS

Certain explosions are liable to occur during the reversing of gas valves while operating openhearth furnaces, the force of these explosions ranging from little puffs to very heavy ones. They are caused by a mixture of the fresh air with carbon monoxide, which must be made to pass off during this operation of reversal.

Many explosions, often unnoticed because of the furnaces being directly connected to a stack, become pronounced when boilers are installed; therefore the flues and settings should be kept tight. It was at first feared that when waste-head boilers were installed heavy explo-

sions would have a disastrous effect on the connecting flues and the boiler settings, and because of this danger especial attention should be given to proper buckstay construction and sufficient explosion doors should be provided to relieve the pressure inside the settings should an explosion take place.

By the proper manner of reversing the valve operation, it has been found by experiment that this difficulty can be practically overcome. Explosion doors can be so designed as to overcome the possibility of injuring and ruining the settings. A most important point is to avoid opening up the stack valves from the gas and air checkers at the same time or so near together as to permit the hot producer gas and air from the checkers to mingle and ignite inside the flues or boiler settings.

When using this way of reversal, the air-stack valve is opened just long enough after the opening of the gas stack to permit the gas that has settled in the checker to pass away and mingle with the existing gases before the hot air is admitted into the flues by the opening of the air-stack valve. When reversing the operation, care should be taken in regard to the corresponding gas and air-stack valves.

In plants where this system of valve operation is carried out, explosions are often reduced from 40 a day, varying in intensity, to but four in 411 consecutive reversals, ofttimes in a period covering five days. A heavy explosion is often due to leakage of a hydraulic valve which, through an operation of the ram, causes the gas valve to unseat.

Another system is where interconnected valves are used, sets of valves being operated simultaneously. Perhaps the best method would be a combination of the two systems; that is, the valves interconnected to assist in their manipulation, but so fixed that the first-mentioned order of control will be followed. The connections should be designed so that enough time will elapse between opening the stack valves and the gas and air valves to make it impossible for the hot producer gas and air to combine.

## REFACING CAPS, NUTS AND HEADERS OF WATER-TUBE BOILERS

A device for refacing boiler tube caps can be made as follows: To a one-horsepower motor is connected a 5-ft. length of flexible shaft, and to the end of the shaft is attached a wooden holder, Fig. 1, to which is secured emery cloth which is used to face the headers. This holder is made by turning a 1-in. thick piece of maple or oak down to 6 in. diameter and facing down to 7/8-in. thick. Another piece of the same wood is turned to 3 1/4 in. and 3/4 in. thick, and a 1/2-in. bolt hole is bored

through the center of both disks. Circular sheets of No. 1½ emery cloth are cut with holes in the center to fit over the bolt and between the larger and smaller wooden disks, the whole being tightened by means of the nut. This will hold the emery cloth on the facing disk and the rig is ready to face up the headers.

For facing the caps and nuts a different rig can be made as follows: Take a blank flange 18 or 20 in. in diameter, drill a 1¼-in. hole in the center and fit in a piece of shafting about 3½ ft. long. The best way is to heat the flange and shrink in the shaft. Then put it in a lathe, face up the flange smooth and take a cut off the full length of the shaft

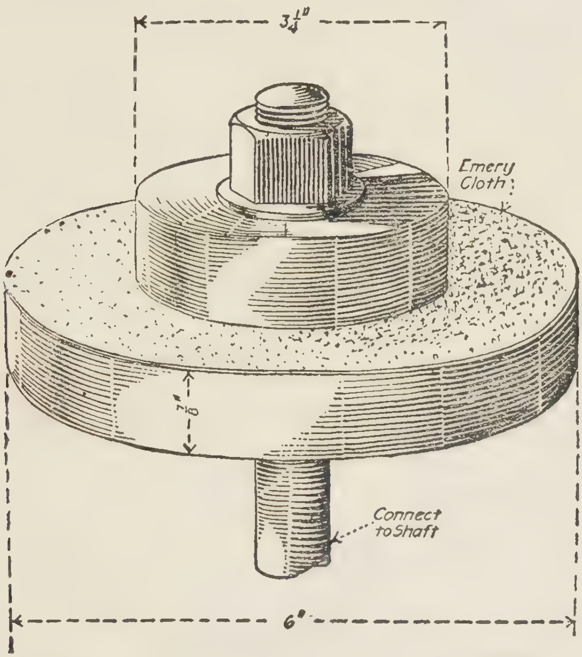



FIG. 1. WOODEN DISK FOR FACING HEADERS

at the time of setting up, so that the face of the disk will be true with the shaft. A strong table about 3½ ft. wide and 4½ ft. long with heavy 6 x 6-in. legs and 2-in. planking was made, bracing the sides well. Bearings are placed as shown in Fig. 2, for the shaft. A 5-in. diameter pulley is placed on the bottom end of the shaft for a driving belt. The disk runs at a speed of 300 to 350 r.p.m. A water pipe is run up to a point above the disk with a ⅛-in. pet-cock on the end to control the supply of water which is fed into a tin trough and which will drop on the center of the disk. Sand is thrown in the trough and the mixture of sand and water is run very slowly on the disk. Caps and nuts are

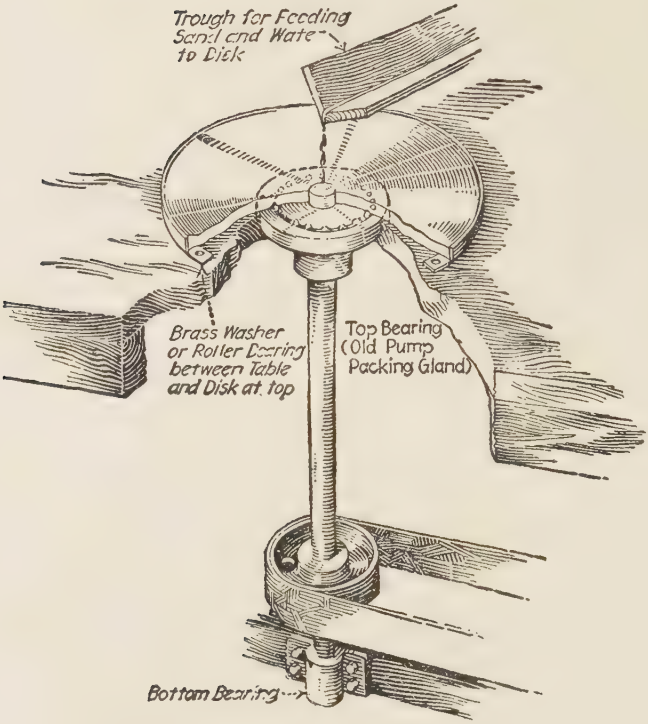



FIG. 2. TABLE AND CAP SURFACING MACHINE

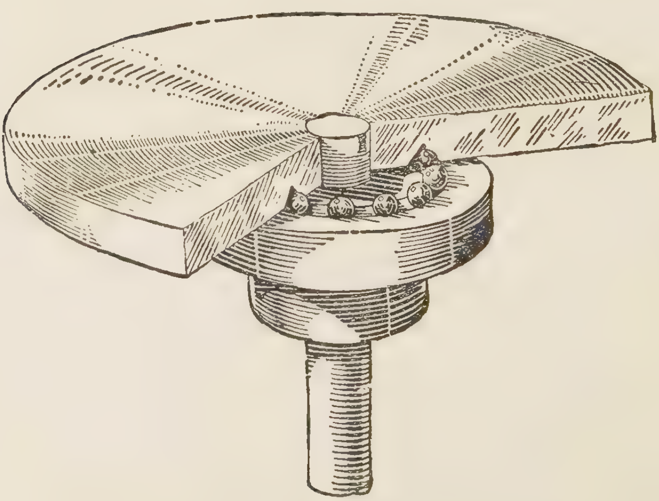


FIG. 3. BALL BEARING FOR SURFACING MACHINE

held on the disk, and they are quickly faced up. Fig. 2 shows the apparatus.

An old pump gland makes a good topbearing by countersinking it in the table and grooving it out and placing balls in, as shown in Fig. 3. It should be babbitted to fit the size of the shaft if it is too large. Caps should be wiped and the finished face oiled immediately.

## RENEWING A WATER-TUBE BOILER HEADER

Replacing a sinuous header in a water-tube boiler is a comparatively simple proposition, but some of the essential details are important.

The illustration shows the various stages of treatment of individual tubes. *D* represents a section of firebrick that has been rounded up

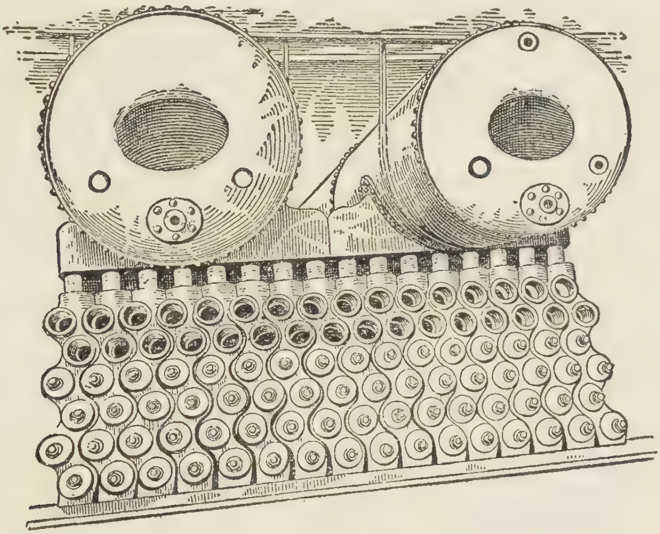


FIG. 1. DOUBLE DRUM BOILER SHOWING HEADERS

to fit the tube hole. Where the tubes are very brittle or crystallized, they will all have to be annealed at the ends where they extend through the header and at the bearing of the joint. This also helps to break the joint, but in most cases it is not necessary to heat and insert brick.

The crimping tool *E*, shown in place in the tube *C*, is the most important tool used; the depth of the jaw, length of the foot and the nicety of fit and adjustment are important. The illustration shows all that is required, but it may take some careful fitting and filing to secure the accuracy which, when obtained, will easily crimp the end of the tube all the way around as shown at *B*. The length of the arm *E* need not be over 18 inches.

After the whole row of tubes has been crimped as shown at *B* and the nipples or risers are cut loose from the drum or saddle, a rope should be passed through a couple of handholes and made fast overhead by a couple of turns in order to facilitate lowering, for as soon as the bottom end from the furnace side is hit with a light timber, the whole header becomes loose.

The tube baffles will hold up the tubes so that there is no danger of their falling or springing and causing a leaky joint at the other end.

Replacing a header is a simple matter. All the tubes have to be annealed and swaged. After annealing each individual tube with hot firebrick, and while the tube is still hot, the tapered pin shown at *G* is

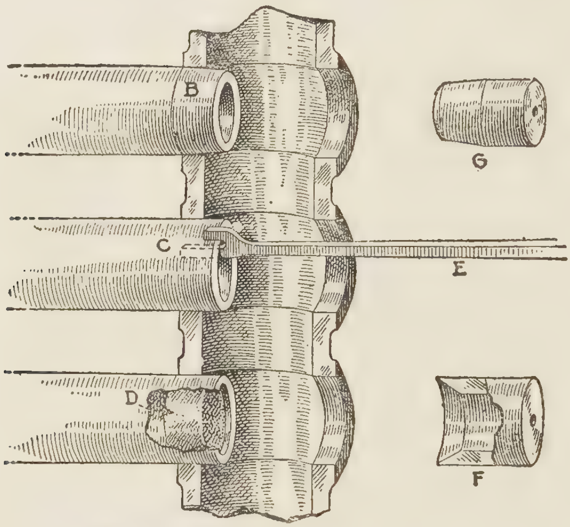



FIG. 2. CRIMPING THE TUBE ENDS

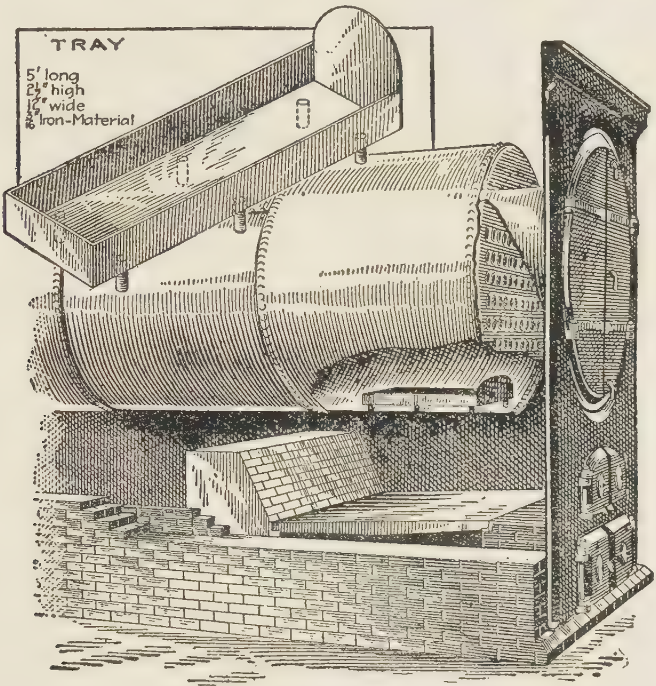
driven into the hole to round the tube up and restore its normal diameter. The cup swage shown at *F* is also used for the same purpose, a small hole being tapped in the bottom of each in which a rod is screwed to facilitate handling. Swages and pins may be made or turned from extra heavy pipe that has been properly forged.

After the tubes are opened out to their normal diameter and annealed, it will be found that strains in the baffle plate, warping of the tubes, or other strains will have drawn the individual tubes out of alignment so that they will not come fair when the header is drawn up to position. For this reason, if the tubes are cleaned and the setting does not prevent, the new header is reset in place while the tubes are in the condition, as shown at *B*, and the header is driven back some ten or twelve inches until the tube ends are all in the clear, after which they are

squared up and the header drawn forward again until its normal position is regained. The nipples or risers, as the case may be, are first put in place. A $\frac{1}{4}$-in. projection is given at each end and they are then rolled in place: this sets and gives a solid foundation to the header, so that the water tube will be even and set square before expanding.

## SCALE DEPOSITED IN TRAY

One of several return-tubular boilers in a certain plant is fed through the blowoff line. The effect on the circulation of the water in the boiler



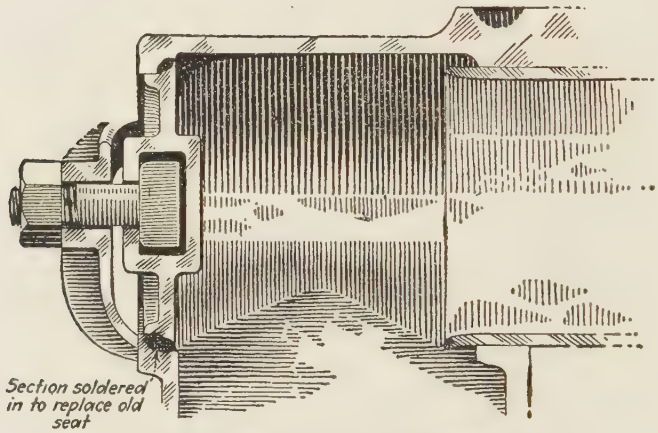

SCALE DEPOSITING TRAY IN BOILER

was such that all loose scale was deposited on the front sheet over the furnace. This resulted in a badly bagged boiler on two occasions. A boiler inspector suggested the introduction of a tray, as shown in the illustration. This is put in place through the front manhole. At times, especially when boiler compound is used, this tray is full of loose scale at the end of two weeks. No loose scale is found in any other part of the boiler. The use of this tray keeps the scale from piling up on the sheet and has done away with the old hazard of a bagged boiler.

## SOLDERING A HANDHOLE SEAT

Some boilers have a beveled ground joint seat at the handholes, and the covers can be changed only when a tube is taken out, and it is a job to keep this boiler tight. Lead gaskets which work very well where the pitting is not too bad in the seat. In one instance a seat was found so badly pitted that the lead gasket could not be compressed in the bottom of the hole.

After scraping the bottom part of the seat, it was tinned and a shoulder of solder built up. It was then peened and scraped down to




WHERE THE SEAT WAS SOLDERED

the proper shape. The necessary lead gasket was then put in place, the boiler closed up and, after getting up steam, cut in on the line.

## STEAM-GAGE-GLASS MARKER

A marker of some kind is usually placed on steam gages, etc., when they are to be read from a distance or when it is desired to read them readily without going close up to see if the pointer is where it should be. Generally, an arrow or some such mark is painted on the gage, but a better plan is to paint the marker on the glass of the gage and then if at any time it is desired to change the point of reading, it will not be necessary to paint a new marker. Shifting the glass to the new position answers the purpose.

## THERMOMETER AS A BOILER BLOWOFF INDICATOR AND TANK COUNTER

A recording thermometer is valuable for the purpose of indicating when a boiler is blown down. The thermometer bulb is placed in the blowoff pipe, inside a short nipple, to protect it from damage by the rapid passage of scale or other matter when blowing down. It is also valuable as an indicator of the condition of the blowoff valves.

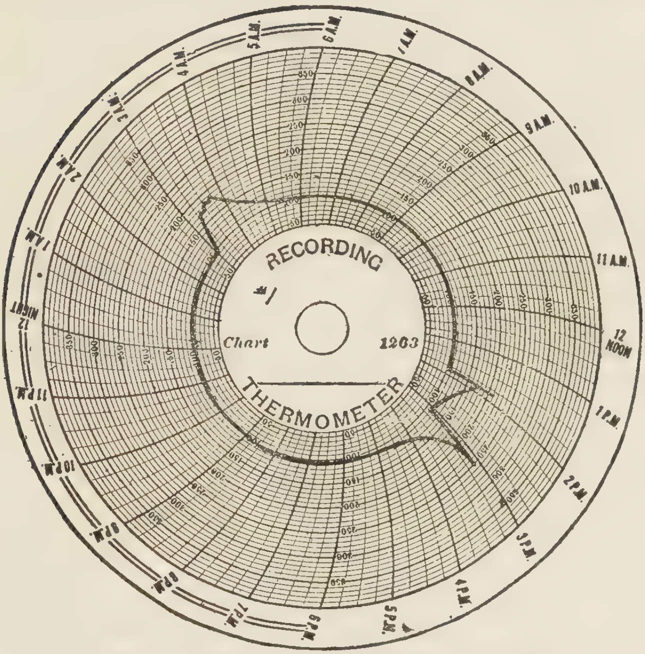



FIG. 1. BLOW-OFF TEMPERATURE CHART

The chart, Fig. 1, shows the temperature of the blowoff pipe at normal condition; it also shows at what time the boilers are blown down and that the recording pen returned to its normal position, indicating that all valves were closed tight. Should a bad leak develop, the chart would show an increased temperature.

For boiler-test work a horizontal cylindrical tank is utilized to measure the water used. About midway in the vertical height is placed a standard mercury thermometer, also the bulb of a recording thermometer. On this use a chart making one revolution in twelve hours, as a fast-moving chart results in a plainer diagram. This is especially desirable when high-capacity tests are run. This chart indicates each

time the tank is filled and emptied and also shows the temperature of the water. The chart, Fig. 2, shows that a test began at 8:50 A.M. and ended at 4:51 P.M., and that 68 tanks of water were used. This is an excellent check on the men whose duty it is to keep a record of the temperature and the amount of water used.

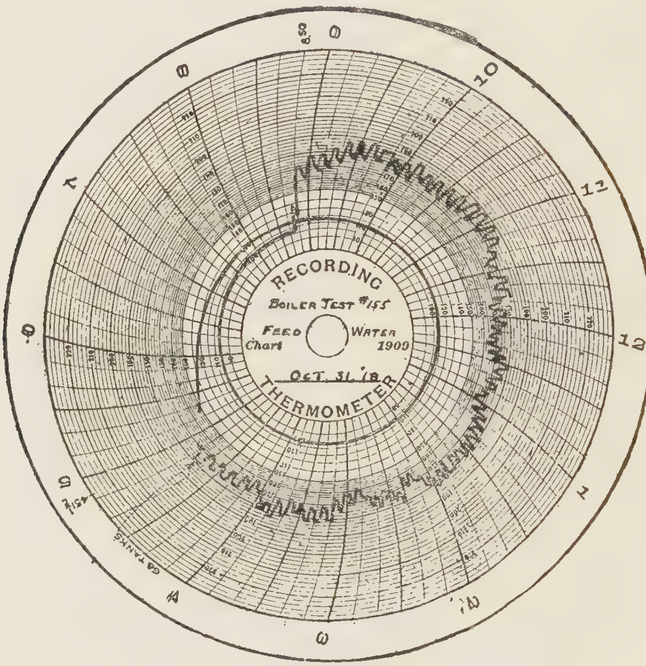



FIG. 2. TANK-FILLING CHART

## USES FOR BROKEN FIREBRICK

Ground firebrick mixed with just enough fireclay to form a binder, together with a small amount of asbestos, makes an excellent cement for patching baffles, arches, door arches and side walls.

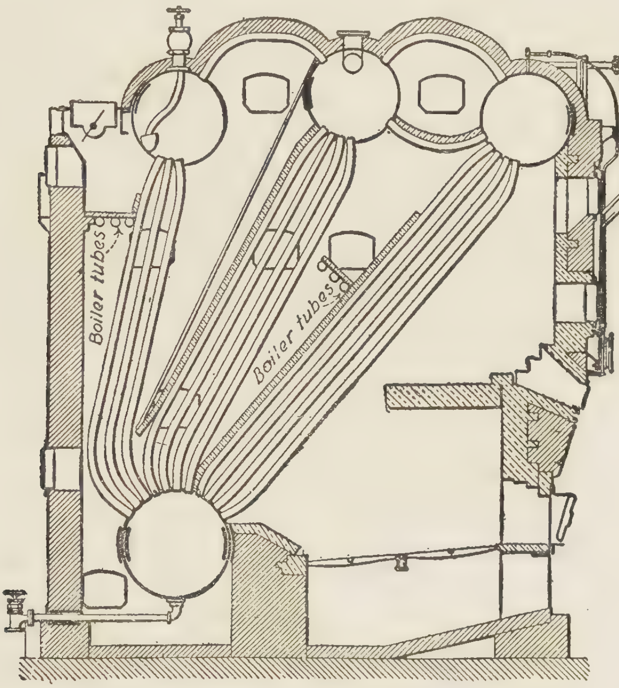
The mixture is as follows: Ground firebrick, 4 parts; fireclay, 1 part; asbestos, 1 part. It is mixed with a saturated solution of salt water. The firebrick should not be ground too fine. The less fireclay and asbestos used the longer the work will stand, and it is better adapted to withstand high temperatures. The mixture should be mixed one day and used the next; in other words, it should be mixed at least twelve hours before it is used.

Broken pipe covering and lagging can be utilized in this way. The asbestos makes the compound more ductile or workable, and it will stay

put better. The mixture should not be too wet, but just moist enough to amalgamate with another body.

## USING BOILER TUBES IN PLACE OF ANGLE IRONS FOR SUPPORTING BAFFLES

The illustration shows a way of using old boiler tubes in place of angle irons to hold up baffles in the Stirling type of boiler. By leaving



BOILER TUBES USED TO SUPPORT BAFFLES

one or both ends of the tubes flush with the outside of the setting, air will pass through them and keep down the temperature of the baffle support, whereas an angle iron would warp and let down the baffle.

## WATER-COLUMN CONNECTIONS

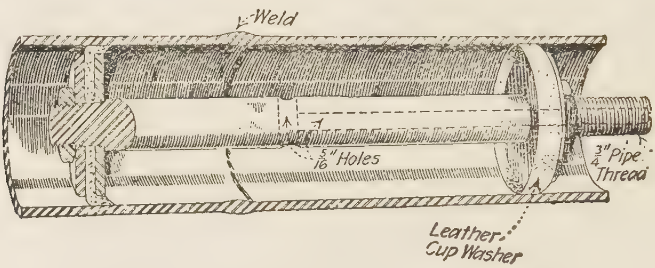
In a battery of boilers some have the steam connection of the water column in the front head and others are connected at the top of the shell; some have the water connection at the bottom of the front head, and one has the connection near the top of the tubes.

The worst performer was the column that had the connection nearest the top of the tubes, as the water would jump 6 in. or more above the true level.

It was decided that the cause was due to the fact that the pipe forming the lower connection was exposed to the hot gases in the smokebox. The pipe was covered with insulating material, which corrected the trouble, as the steam formed in the pipe carried the water up into the water column, where there was room for separation to take place.

## WELD-TESTING DEVICE

In order to test welds in boiler tubes, the device illustrated can be made. It consists of two pistons, made as shown, one to come on each side of the weld. A rubber hose is attached to the rod projection, and




DESIGN AND APPLICATION OF TUBE TESTER

compressed air is admitted through the hollow rod and outlets. Thick soapsuds are applied to the tube over the weld, and if a leak is present bubbles will form. No defective welds can get past if proper attention is given.

## *SECTION III*

# KINKS IN PUMPS

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### DRAIN TRENCHES IN PUMP AND CONDENSER PITS

MANY pump and condenser pits are provided with one or two floor drains, but the assistance of a broom is required to complete the drainage, and drain pipes have a way of getting stopped up.

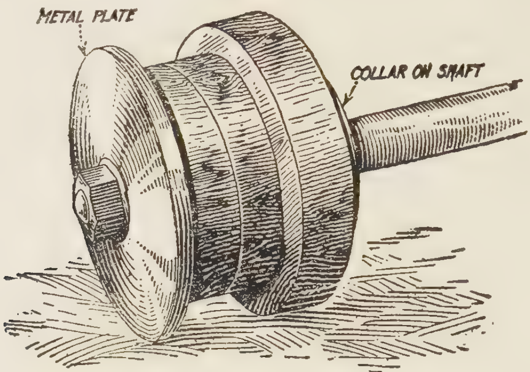
Drain trenches should be run the full length of the pits and should be covered with cast-iron grids instead of plates. The trenches should be so located that no part of the floor is more than 6 or 8 ft. from a trench, and the trenches should be about one foot wide and deep. The floor should slope toward the trenches at least one inch for every three or four feet. Drains from bedplates, glands and water seals should be piped to the trenches and not allowed to run across the floor. If proper attention is given to lighting and drainage, there will be no excuse for the operators not keeping the pit and machinery within it clean and in good order.

### EMERGENCY PUMP REPAIR

It was found that the metal portion of the piston of an electrically driven pump had been practically eaten up by the acid of the mine water. An emergency repair was made by using a piece of 2-in. oak plank sawed out to a circular section $\frac{1}{4}$ in. less in diameter than the bore of the pump cylinder. The edge of this was then cut away to a depth sufficient to take $\frac{5}{8}$-in. packing and for a length of 1 in. A piece of 1-in. oak board was then procured, sawed to this same diameter and attached to a piece of 2-in. plank to make the piston of the proper length.

As the available length of the piston rod was not sufficient to accommodate another 1-in. piece, a metal plate was used. This was made

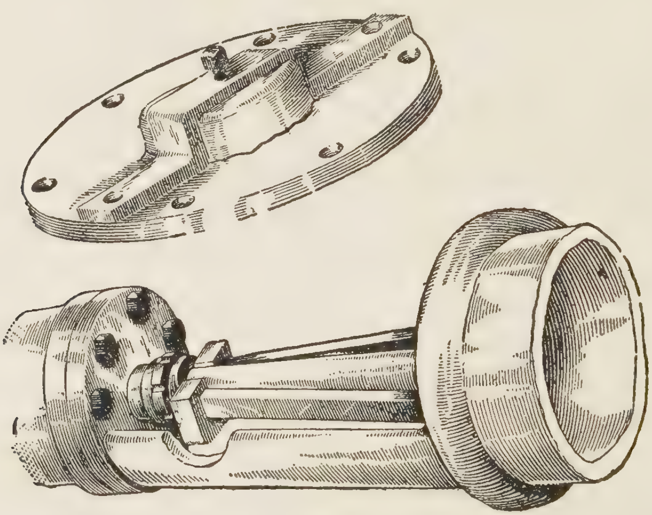
slightly smaller than the bore of the pump and was held in place by the regular piston-rod nut.




HOW PUMP REPAIR WAS MADE

## EMERGENCY PUMP REPAIRS

The head on the steam end of a boiler-feed pump was cracked as shown. A piece of strap iron, $\frac{3}{4} \times 1\frac{1}{2}$ in., was put across the head with a $\frac{5}{8}$-in. setscrew in the center. Iron cement completed a permanent repair.



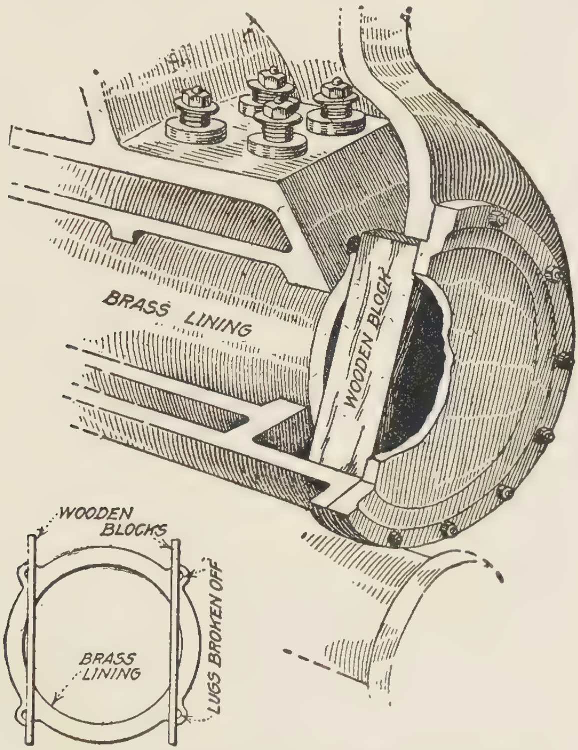
TWO DIFFICULT SITUATIONS OVERCOME

The face of the packing nut on the water end of the pump was broken off (probably screwed up too tight). A piece of 2 x 6 oak was found, and a notched block was made, as illustrated. Two 1 x 3 oak boards

were then cut the right length, the block was placed with the slot under the rod and against the face of packing nut, then securely braced with the boards.

This repair held for several days until a new packing nut was secured.

The cold water supplied by a duplex pump to the tank that supplies the heaters seemed to have a corrosive effect on the cast iron of the pump, especially around the capscrews that held the brass lining in



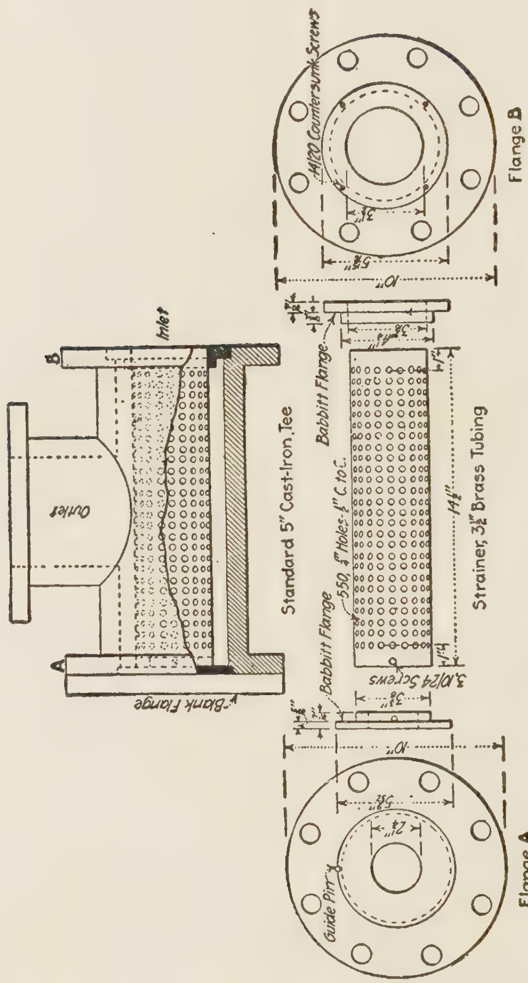

LINING HELD IN PLACE BY WOODEN BLOCKS

the water end, for it ate away the threads so that the screws would not hold the lining in place. After taking the water-end head off, it was found that the lining was loose, all the screws out and the four lugs were broken off. The illustration shows how it was repaired. By placing pieces of wood about 6 in. long, $7/8$ in. thick and about $1/32$ in. wider than the distance between the end of the lining (when it was in place) and the head and pulling the head up solid, it was possible to use the pump and keep up the supply of water until a new lining was procured.

## HOMEMADE PUMP-LINE STRAINER

The strainer, made as illustrated, was placed in the water supply line for a turbine air pump serving a 2500-kw. turbine.

The supply line is 4 in. A 5-in. flange was bored out to fit the 4-in.



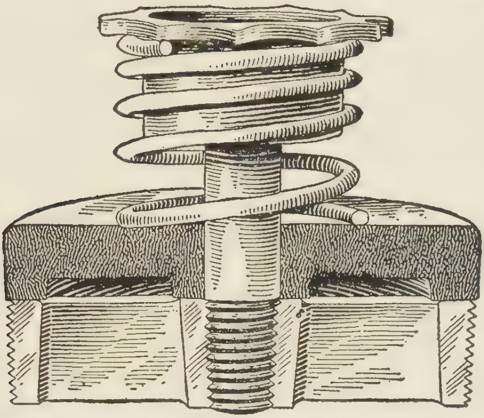

DETAIL OF HOME-MADE PUMP-LINE STRAINER

pipe and to which the flange *B* of the tee was bolted. The outlet flange was fixed in the same manner. The hole in the babbitt flange fastened into the flange *B*, is tapered so as to make it easy to insert the strainer. The babbitt flange in flange *A* is fastened to the strainer by means of three machine screws, and has a hole in it to make it easy to remove and to steady the strainer when being replaced. If the lathe is too

small to handle the tee, the machine work can be done on a drill press with a home-made cutter.

## IMPROVEMENT IN PUMP VALVES

Shortly after hard-rubber composition valves are put in use, the parts over the openings between the ribs of the seats become raised slightly, and as the valve does not always seat in exactly the same position, the raised part may prevent tight closing. A remedy is to turn out the central portion, forming a circular groove as shown in the illustration.

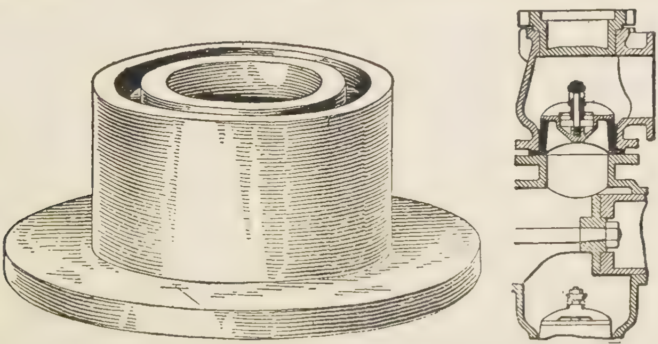


RUBBER PUMP VALVE IMPROVED BY REDUCING FACE

The valves do not warp; when they require refacing it is much less labor than with a solid face.

## IMPROVED PUMP-VALVE SEAT

The illustration shows an improved pump-valve seat used on pumps in a mine shaft. The water is high in sulphur and soon eats the valve



PUMP-VALVE SEAT GROOVED AND FILLED WITH SOLDER

seats out where the water discharges over the outer edge of the seat. Turning a groove in the valve seat and filling it with solder, half lead and half tin, will prolong the life of the seat 50 per cent. At the left in the illustration the removable seat with the groove is shown and at the right its position in the pump.

## INSTALLATION AND USE OF AIR CHAMBERS

The illustrations show arrangements suitable to various locations, all of which will work satisfactorily. Of these, Fig. 1, where a riser turns into a horizontal run, is probably the most desirable, as it requires fewest fittings; these are all standard and in it the air column

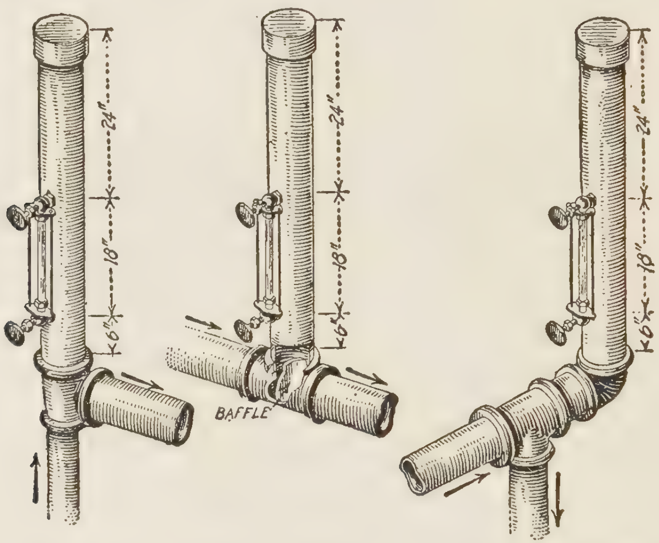



FIG. 1. AIR CHAMBER

FIG. 2. BAFFLE IN TEE

FIG. 3. ANOTHER ARRANGEMENT

meets the flow most directly. Equally effective is that shown in Fig. 2, for use in horizontal runs. Many similar air chambers have been condemned because the baffle to direct the stream upward has been omitted, The baffle need not fit water-tight, but should fit reasonably close and be firmly fastened by welding or screwed clips, as in long lines the pressure against it is considerable.

Arrangements shown in Figs. 3 and 4, where a horizontal line turns sideways or downward, are also good, but that shown in Fig. 5 should not be installed except where there is a supply of compressed air available for filling.

The best results are obtained by making the air chamber of the

same size pipe as the feed line and obtaining the necessary volume by increasing its length. If it is made either larger or smaller, there will be an abrupt change of velocity in the water entering or leaving the air chamber, with a corresponding loss of energy and efficiency. For the average plant the dimensions shown on the sketches are ample, but for very long lines, such as occur in pumping plants, etc., the height should be considerably increased.

But no matter how well located the air chamber is, it must contain sufficient air to provide a cushion, and in plants where no supply of compressed air at or above boiler pressure is available this is often dif-

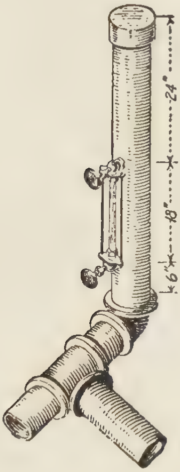



FIG. 4. A GOOD ARRANGEMENT

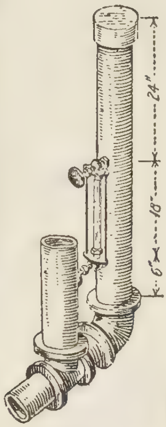



FIG. 5. REQUIRES COMPRESSED AIR

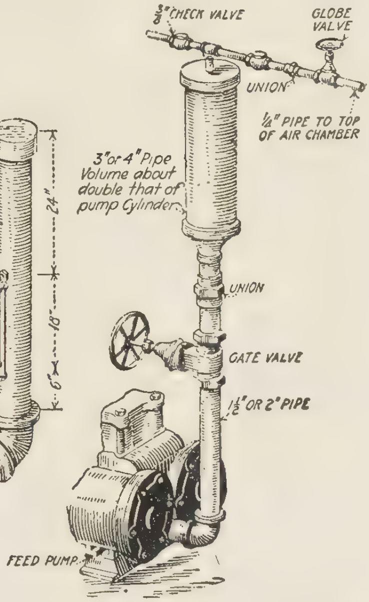


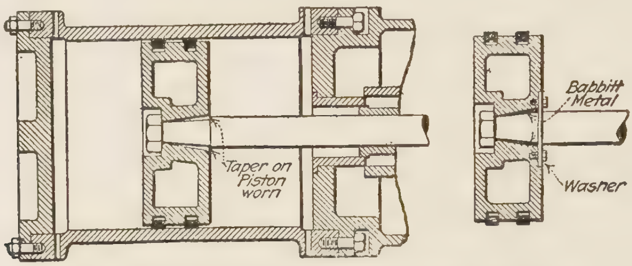

FIG. 6. HOW AIR IS SUPPLIED

ficult to maintain, as the solvent power of water for air increases directly with the pressure. For instance, at 150 lb. it will dissolve eleven times what it would in an open tank, and any air in the air chamber rapidly disappears. Under such conditions it is customary to use the feed pump as a compressor, where the suction pressure is not too high, opening the water-cylinder drain-cock on the suction stroke, or with an open heater lowering the water level during a light-load period so that the pump sucks some air.

A slightly more elaborate but effective arrangement is shown in Fig. 6. This also has the advantage that by throttling the valve it can be arranged to deliver just the quantity of air desired.

## LOOSE AIR-PUMP PLUNGER MADE FAST

An air pump began pounding badly and the vacuum dropped back at intervals. Upon taking out the plunger, it was found that the piston was loose on the rod, as shown in the illustration. It was made fast in the following way: A washer was made out of ½-in. copper to fit the piston rod and fastened to the piston with two ½-in. capscrews.



PISTON AND ROD BEFORE AND AFTER REPAIRS

The piston and rod were replaced in the pump, the piston packing put in to hold the piston central and the follower plate bolted down. Babbitt metal was then poured into the recess and peened down, and after fastening the washer securely, the job was done.

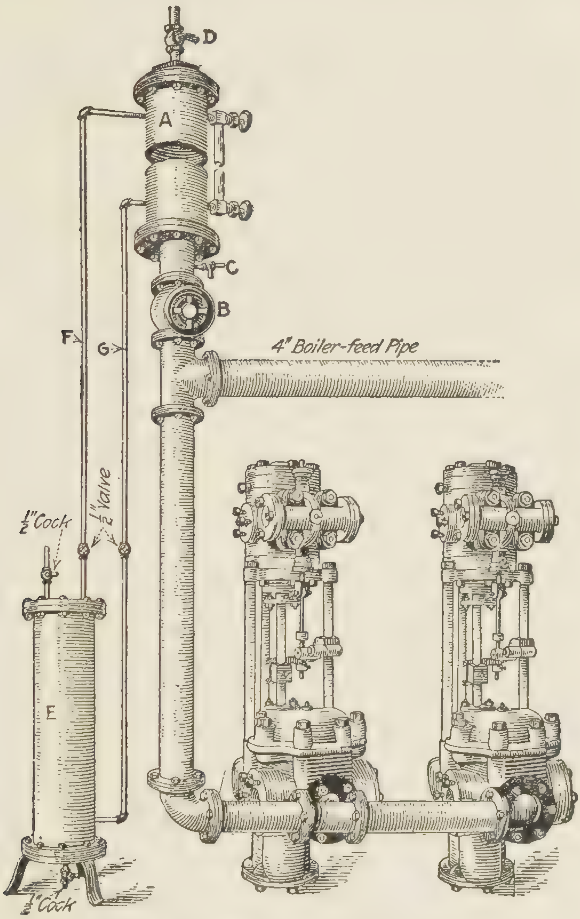
## MAINTAINING AIR IN AIR CHAMBERS

The desirability of air chambers on boiler-feed lines, at least when reciprocating pumps are used, is recognized by most engineers. Two small reciprocating pumps were used as boiler feeders, and were connected to a common suction pipe about 80 ft. long, and the effect of synchronizing was to set up heavy pulsation on the discharge side, which caused the boiler-feed check valves to clatter and which also broke a tube in the economizer.

An air chamber *A* was then placed on the discharge side, consisting of 6 ft. of 8-in. pipe with a plug at the top, a water glass being fitted so that the air volume could be observed. This air chamber was put in operation by first closing a 4-in. valve *B* at the bottom and drawing the water from it by means of ½-in. cock *C* just above the latter valve, while the air entered through another ½-in. cock *D* at the top. The 4-in. valve was then opened and a small air cushion formed.

Although no leak could be detected, the air volume gradually decreased, due perhaps to its absorption by the water, and the necessity for some kind of air pump was obvious. The average pressure in the

feed line was about 200 lb. and the air compression would furnish only 65 lb. A displacement ring was therefore installed, the material for which was mostly obtained from the scrap pile. This consisted of another section of 8-in. pipe *E* set up in a vertical position but about 10 ft. lower than the air chamber. A ½-in. cock was placed at both




ARRANGEMENT OF AIR CHARGING CHAMBERS

top and bottom and ½-in. pipes *F* and *G* connecting the top and bottom of the two chambers, with valves placed near the bottom chamber. The air in the latter was displaced by the water which came down the ½-in. pipes until the pressures were equalized, and then the compressed air ascended in a few seconds to the upper chamber. A few operations sufficed to fill the latter three-quarters full of compressed air, and a

few minutes' daily attention was all that was required to keep it there. All pulsation in the feed lines disappeared.

## REPAIRING PUMP PISTON ROD

Should the piston rod of a small pump break, drill a ½-in. hole parallel with the rod in each end where it was broken and tap them

SUCTION SETTLING POCKET AND PUMP-ROD REPAIR

out to ⅝ in., put in a continuous-thread stud and screw it up tight until the rod ends come together, as shown. The pump may thus be kept running until another rod can be obtained.

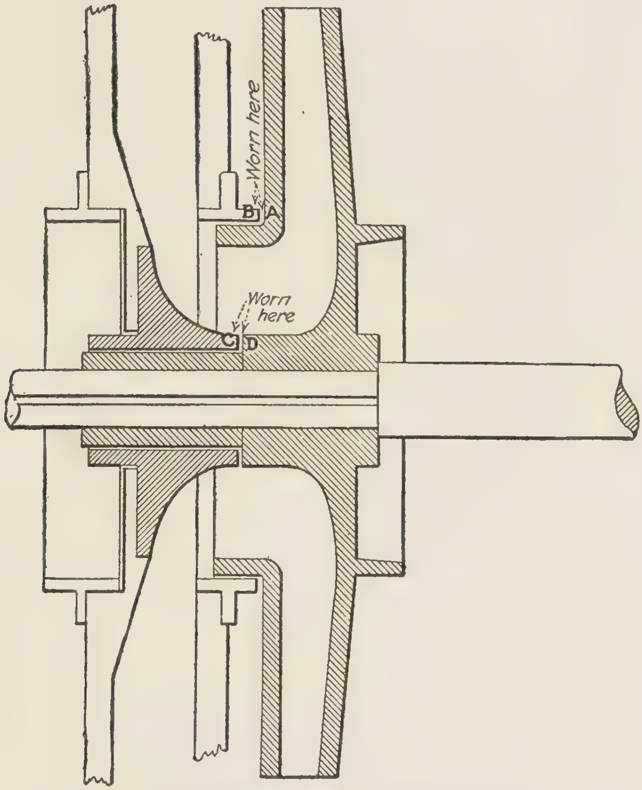
## REPAIRING A CENTRIFUGAL PUMP

A four-stage centrifugal pump used for boiler feeding, speed 2100 r.p.m., and built to deliver about 200 gal. per minute at a pressure of 200 lb., operated satisfactorily until a marked falling off in capacity was observed.

When the disks and pump rotors were all removed, it was discovered that the impellers were badly worn on the suction side, as shown in the illustration at *A, B, C* and *D,* which also shows the wear on the renewable sealing rings and suction ring, this wear being caused by the rotating parts pulling endwise when the thrust bearing let go. The impellers did not show any wear due to erosion, so it was decided to repair them by filling in the worn places with bronze. The filling in of the impellers was done with an oxyacetylene-welding outfit.

By reference to a cut of the pump and measurements taken from the diaphragms the total end clearance was determined to be $^7/_{64}$ in., and the impellers and sealing rings were finished to give that clearance. A new shaft was made to the same dimensions as the old one, and as it was thought best to try the pump for end clearance before assembling it in place, it was assembled on the shop floor and the end clearance was found to be ⅛ in. The parts were assembled in the casing, all the connections made, and the shaft was then pushed as far as it would go toward the discharge end and the shaft marked in line with the end of the outboard bearing nearest the thrust bearing. Then it was pushed as far as it would go toward the suction end and the shaft marked at the end of the same bearing. The distance between these two marks was a measure of the end clearance, and it was found to be the same as

when assembled on the shop floor. The clearance was then split and a new mark made on the shaft one-half the distance between the other two and the shaft pushed toward the discharge end until the new mark was even with the end of the bearing. A new thrust bearing was then put in place and shims placed between it and the end of the outboard bearing to bring the center mark in line with the end of the bearing.

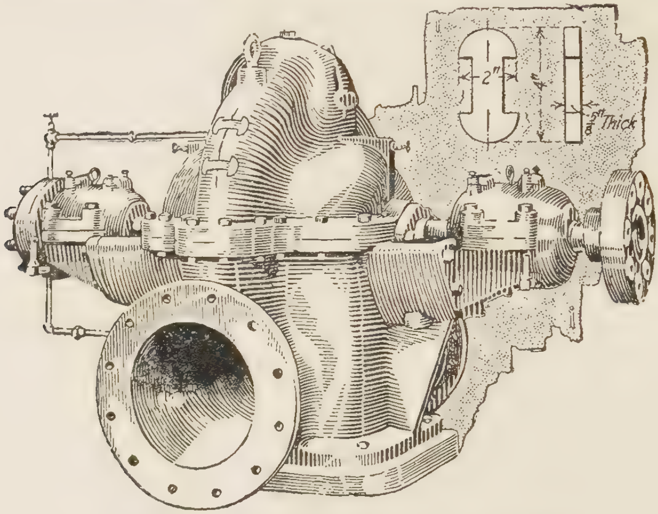



WORN IMPELLER AND TURBINE ROTOR

## REPAIRING CRACKED PUMP CASING

The discharge casing of a large centrifugal pump developed a crack while the pump and its 30-in. suction line were being tested. The crack was on the top of the upper half of the casing, running lengthwise and practically in a straight line for 18 in. To repair this fracture, the casing was chipped at two equidistant points from the ends of the crack to receive the links, as shown in the figure. These links were made of $\frac{5}{8}$-in. boiler plate and constructed to give a snug fit when cold. The crack was then treated to an iron-cement preparation while a low

vacuum was kept on the pump; the links, after being given a good red heat, were dropped into place and a piece of a hacksaw blade slipped between the lips of the links and casing, giving a good fit. The crack was drawn together firmly as the links cooled.



HOW THE CRACKED CASING WAS REPAIRED

## WHY A CENTRIFUGAL PUMP FAILED TO FEED BOILERS

In one instance one or two three-stage centrifugal pumps were started and appeared to be operating all right, but as soon as the throttle was closed on No. 2 pump the pressure began to drop and No. 2 had to be put in service again to keep the water in the boilers.

Since the load was very light at this time, No. 2 pump was stopped to see if No. 1 would pick up the pressure after a few minutes; but instead of stopping, No. 2 pump started to run back after the throttle was closed.

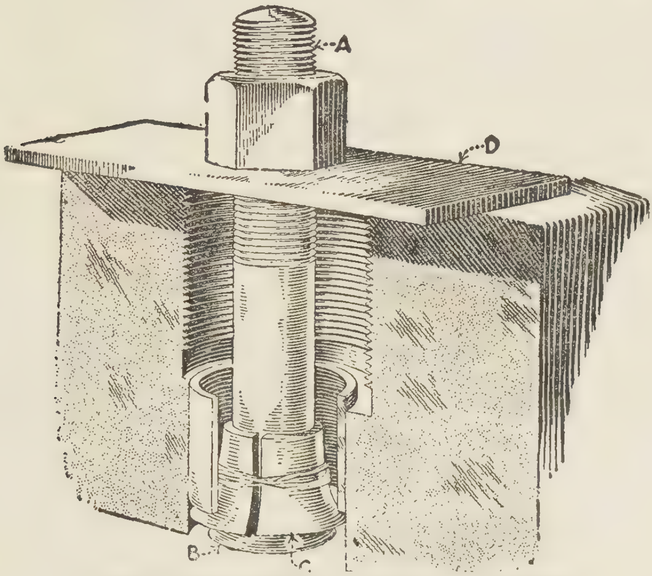
This showed conclusively that the discharge check valve on No. 2 was the cause of all the trouble, for as soon as its speed dropped sufficiently, No. 1 pump had bypassed its water through the other and thus could not keep up the pressure.

## TOOL FOR PULLING WORN HYDRAULIC VALVE SEATS

For pulling out worn hydraulic valve seats, the tool shown herewith is a time and labor saver. To make, turn down a piece of round stock long enough to be used on the pump, as shown at *A*, and threaded for a 7/8-in. nut, providing enough stock at the other end to turn a 30-deg. taper and of a diameter to make a sliding fit through the valve seat.

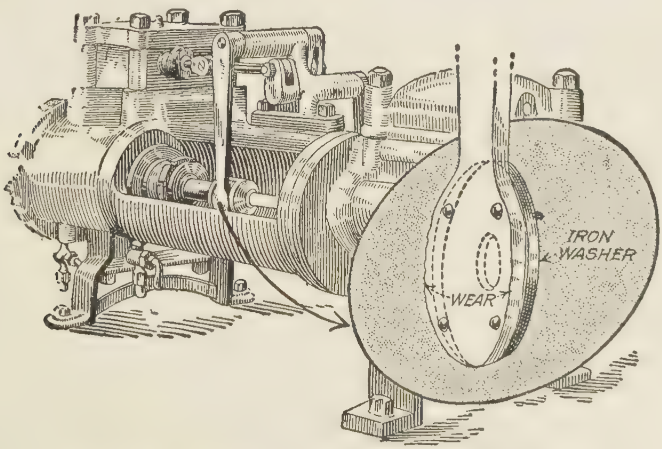
Make a bushing *C* to fit half-way down on the taper of the puller, the bottom end of the bushing having a slight lip. Then split the bushing with a hacksaw and the tool is made.

To use, push the puller through the valve seat and then put the bushing on the pusher, holding it together with a rubber band. Next



HOW THE VALVE-SEAT PULLER IS APPLIED

push the bushing down over the taper of the puller until a good hold is obtained on the valve seat; then put the iron clamp *D* over the puller and jack the seat out with the nut.



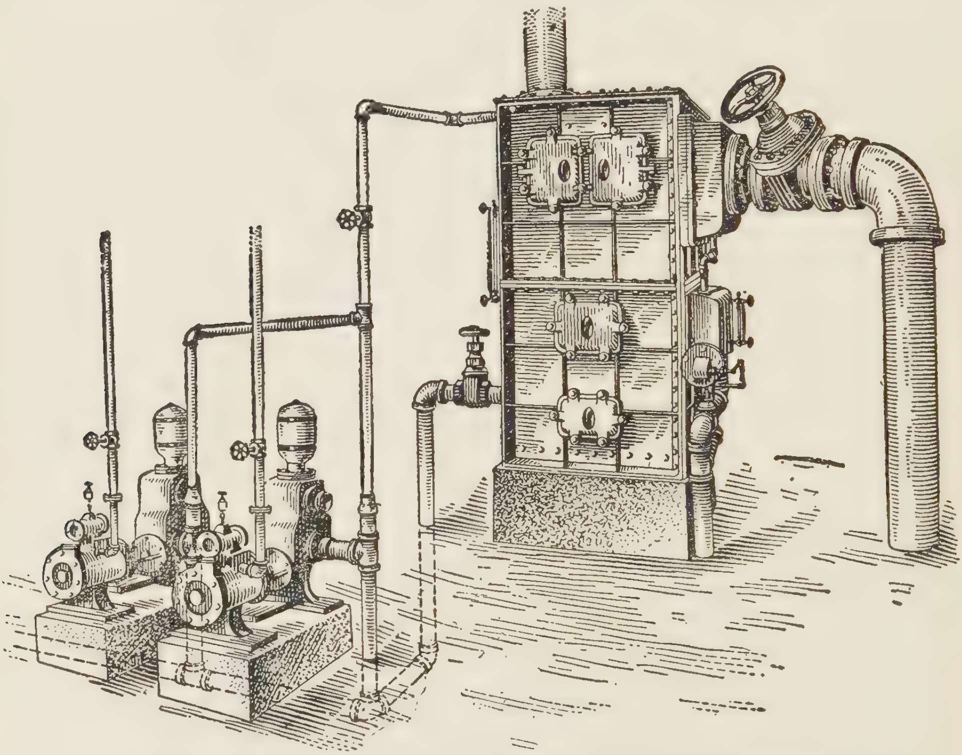
WASHER RIVETED ON WORN END OF PUMP ARM

## WORN PUMP-VALVE ARM REPAIRED

Trouble was had with a hotwell pump. The long arm becoming worn at the spool allowed the arm to slip out of the spool, stopping the pump. A quick and satisfactory repair was made by riveting a 1-in. washer on the end of the arm with four small rivets, as shown on page 53. No more trouble was had with the arm slipping out of the spool, and the washer can be quickly replaced when it becomes worn.

## VAPOR RELIEF FROM SUCTION PIPE

The illustration shows how the problem of water-hammer in a pump suction line was solved in one plant. The open feed-water heater delivered the water at about 212 deg. F., but the hammering ceased when



VAPOR PIPE FROM PUMP SUCTION PREVENTS WATER-HAMMER

the exhaust steam inlet to the heater was choked and the temperature of the water lowered, so it was surmised that steam bubbles forming in the suction pipe caused the trouble. Allowing these bubbles to rise in the standpipes and return to the heater stopped the hammering entirely.

*SECTION IV*

# KINKS IN VALVES

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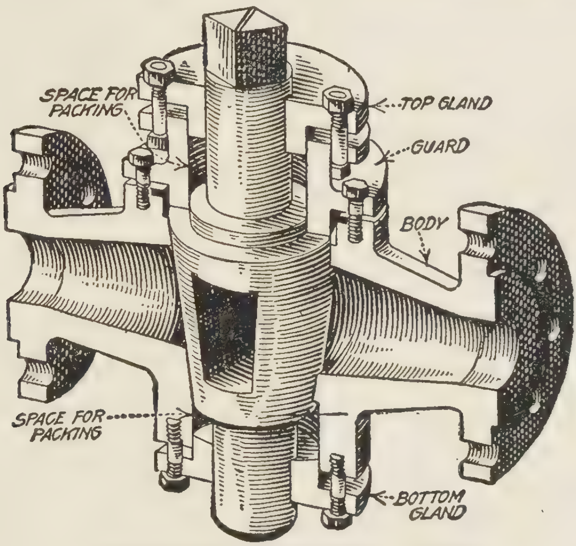
## BOILER BLOWOFF VALVES

THE stop-cock shown in the illustration is packed at both sides of the plug. The pressure on the glands at top and bottom as applied by the stud bolts and the nuts adjusts the friction between the plug and



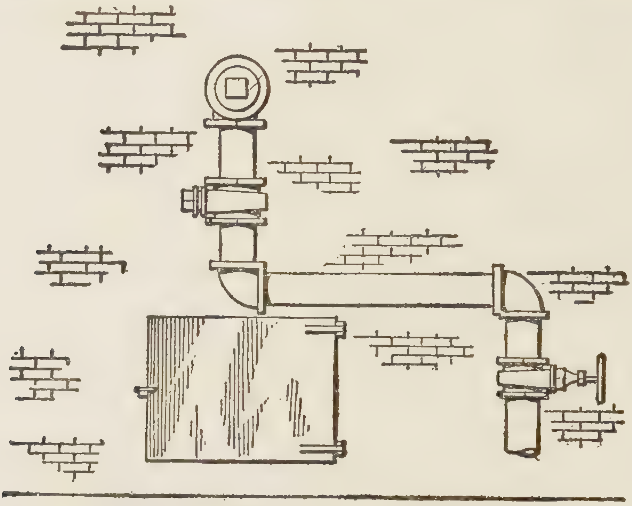

BLOWOFF COCK OF SPECIAL DESIGN

the body by raising or lowering the wedge-shaped plug. The packing acts as a bearing, and the plug moves with an easy and even motion. Besides the packing gland there is an extra guard on top to prevent the plug from blowing out.

The illustration shows a blowoff-piping arrangement that can be used with excellent results. On the end of the pipe that extends from the boiler through the brick wall, a tee is used instead of an elbow

and when the boiler is inspected the plug in the outer end of this tee is removed, making it possible to ascertain the exact condition of the pipe. Both the asbestos-packed plug cock and the gate valve are located in vertical sections of the pipe.

The gate valve is first opened wide, then the cock is opened to its full capacity. When the water level is lowered to the proper point, the cock is slowly closed, then the gate valve is closed. One advantage of this plan is that scale and sediment go through the gate valve when it is wide open and is therefore not likely to injure the surfaces that come



ONE ARRANGEMENT OF BLOWOFF PIPING

together when the valve is shut, and anything that can get through the pipe will pass through the valve. Sediment cannot lodge in the bottom of the valve, because it is in a vertical position.

If the plug cock leaks a little it does no harm, because it is used only to gradually start the flow of water through the blowoff pipe, then to slowly bring it to a state of rest. If small pieces of scale should be caught in the cock when nearly closed, they would be sheared off without preventing the cock from closing or injuring them.

## CARE OF PIPE-LINE VALVES

When valves become hard to open and close, some engineers use a wrench or bar without any thought of locating and correcting the defect. In the first place, the packing should be kept lubricated and should be renewed often enough to prevent leakage. Many high-pressure gate valves can be packed when wide open and under pressure.

The stems of rising-stem valves should be given an application of graphite and cylinder oil at regular intervals. If this attention does not correct the trouble, the stem may be binding at the threads. To overcome this, the threads should be given an application of valve-grinding compound, and the valve should be opened and closed a few times. The grinding compound should then be cleaned off with kerosene.

Gate valves sometimes work hard on account of binding between the wheel hub or nut and the yoke. The nut should be removed from the yoke and cleaned and, if necessary, dressed off with a file. Before being replaced, the nut should be coated with graphite and cup grease. For positive assurance against the trouble occurring again, drill an oil hole in the yoke or put on a grease cup.

## CAST BRASS VALVE SEATS POROUS

In a certain plant the blowoff valves gave a lot of trouble. Several new ones were faced up and tested with city water pressure, but only one out of five was fit to use; the others leaked badly because the casting was spongy or porous.

A coat of solder applied to the backs of the disks made them tight.

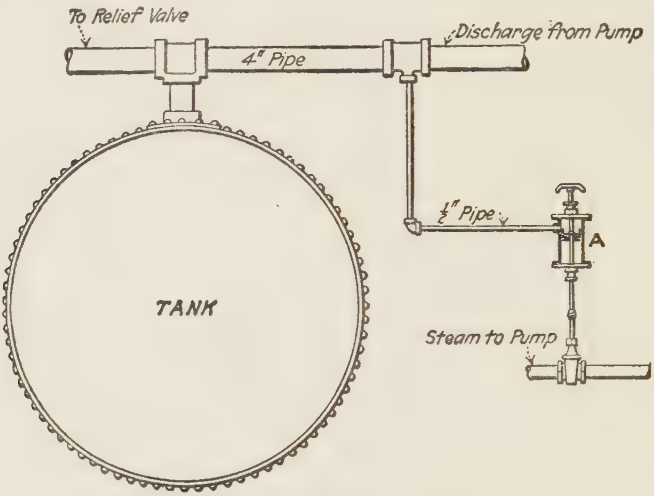
## COLUMN BLOWOFF VALVE LEAKS

Considerable trouble is had with the blowoff valve on the bottom of the gage-glass dripping constantly. Although they may be frequently renewed they will not stay tight long. Extending the pipe from the bottom of the gage-glass and putting the blowoff valve on the lower end of the pipe seems to protect the valve to some extent and prevents leakage. In that way the blowoff valve lasts considerable longer.

## HOME-MADE AUTOMATIC PUMP STOP VALVE

In a certain instance water was pumped into a closed iron tank, and the relief valve would occasionally be open for a considerable time before someone came along and shut off the steam supply to the pump. Finally, the stop device shown herewith was made. It consisted of two stuffing-boxes which are attached to the ends of an old 3-in. diameter pump cylinder taken from an iron hand pump. A ½-in. hole was drilled and tapped in the side of the cylinder for a pipe, which was connected to the pump discharge pipe. The cup leather of the old plunger was used with an iron washer behind it. A ⅜-in. rod passes through all and is fastened to the stem of a lift gate valve, a handle being fitted to the top of the rod. The whole is shown in the illustration. To start

the pump the handle is raised; this admits steam to the pump cylinder, and the friction of the packing in the stuffing-boxes holds the valve in an open position. When the tank is filled, the pressure rises and, backing down through the ½-in. pipe, forces the cup piston in the cylinder down, thus closing the steam valve. The relief valve was set to open at 10 lb. pressure.




PIPING AND VALVE CONTROL

## KEEPING CHECK VALVES FROM HAMMERING

Hammering of check valves can be corrected as follows: Cut a piece of coil spring the right length to go in between the cap and the swing check to prevent the valve opening wider than necessary. The spring should exert the least force that will stop the hammering because it is a resistance against the flow of the water. The same is true, of course, with regard to the springs on pump valves.

## LEAKY SAFETY-VALVE SEATS

If a safety valve leaks after having been reseated or ground in, an examination may show that the leakage occurs between the seat and the valve body. When the valve is cold, the seat may be found to be quite loose. This may be accounted for by the fact that the unequal expansion of the bronze seat and iron body compresses the seat. If the seat seems to be tight, it is a good plan to invert the valve and fill it with water in order to locate any leakage.

The remedy for a loose seat is to expand it with an ordinary tube expander. If the seat is of sufficient length, the expanding should be

done below the top of it. Afterward the valve should be reseated and ground in in the usual manner. Some types of globe and angle valves can be repaired in the same manner.

## MAKING A PRESSURE REGULATOR MORE SENSITIVE

The pressure of a heating system would drop, and the regulating valve would remain open until the pressure built up and forced the back-pressure valve to open before the reducing valve would close.

While investigating it was noticed that the diaphragm chamber of the reducing valve was warm, and as the pipe leading to it was trapped, it was concluded that when the diaphragm lowered, the water in the chamber below it was pushed into the steam pipe and carried away, and when the pressure accumulated enough to push the diaphragm up, steam took its place in the pipe and chamber.

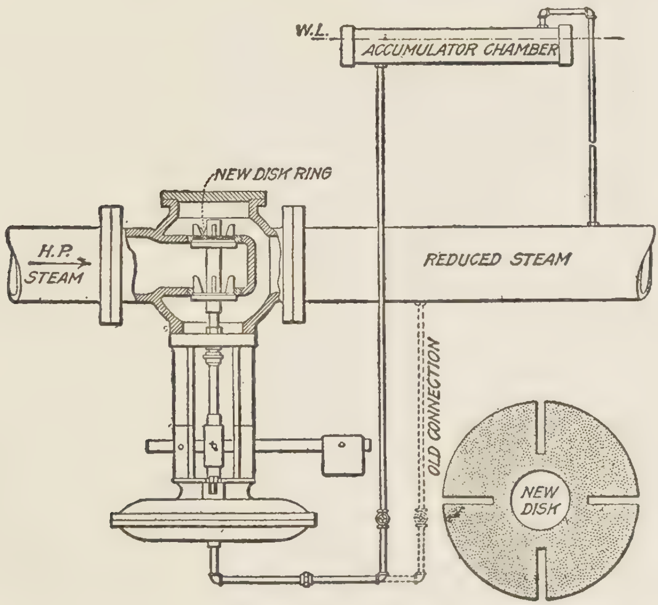



FIG. 1. CHANGED PIPING TO DIAPHRAGM AND NEW VALVE DISK

To remedy this condition a chamber of 2-in. pipe and suitable fittings of sufficient capacity to hold enough water to fill the diaphragm chamber and connecting piping was made, and installed horizontally near the ceiling and connected from the under side at one end with the diaphragm piping and from the upper side at the other end with the reduced-pressure piping, Fig. 1. This resulted in marked improvement.

The reason for giving the water in the diaphragm pipe an increased height was to get a greater pressure on the diaphragm in order to take up all lost motion in one direction that the 2-in. horizontal pipe afforded. It also gave sufficient capacity for the water head in it to vary but an inch or less in height and so kept the water column constant.

However, with this change the valve did not operate satisfactorily as it seemed to open too wide and showed a tendency to dance. The valve was taken apart and a disk made out of a brass pump-valve plate was slipped over the valve spindle against the wings of the valve and pinned there, Fig. 2. The valve was assembled and the thing was done.

It was reasoned that when the valve opened wide the steam issuing

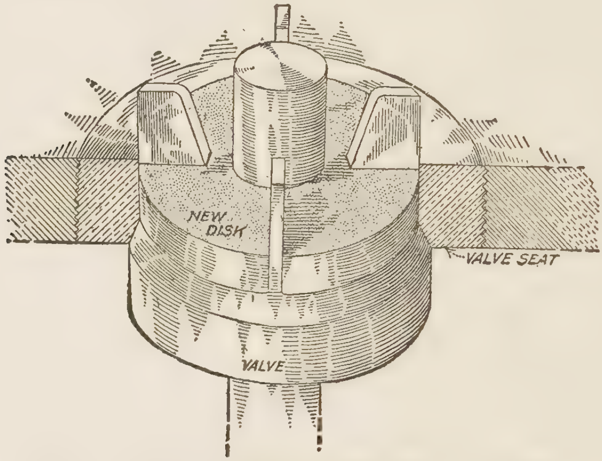



FIG. 2. APPLICATION OF NEW DISK TO VALVE

through the valve, which was a double-seated one, struck the disk forming the head with such velocity that it tended to force the valve further open and unbalance it, as the steam issuing through the other seat met no such obstacle, and that the disk that was installed provided the resistance. The two forces then balanced each other and left the diaphragm to take care of only the pressure variation.

## METHOD OF TURNING ON STEAM IN LARGE LINES

Accidents and consequent losses, both direct and indirect, due to the failure of steam piping and fittings while being cut into service when steam is being turned in, have apparently all been due to expansion strains rather than pressure strains. The expansion strains which caused the damage were usually different from those which were present after the line had been heated to full temperature.

A further analysis discloses the fact that the particular form of expansion causing the trouble has been in most cases due to the presence of air in the steam line at the time steam was being turned on. Air, having approximately twice the density of steam, remains at the bottom of the pipe and prevents the steam from coming in contact with (and thereby expanding) parts of the piping. On a straight run of horizontal piping the result is a tendency to "rainbow" the piping. This has been proved by actual test. The further result of this action is to put a heavy compression strain on the upper half of all joints and fittings and a corresponding tensile strain on the lower half. This trouble is experienced to a greater extent with large than with small piping. This may be due either to the pipe being so small that the air and steam do not remain stratified, or possibly to the great flexibility of the small piping.

The method of turning on steam, which will prevent trouble of this kind, is as follows:

All the drains and air vents on the line are opened. Steam is turned into the line very rapidly, the valve being opened one-fourth to one-half its full opening. This applies not only to low pressure, but to high pressure as well. This procedure results in driving the air out of the line very raidly and allows the pipe to heat uniformly. To engineers who have been accustomed to "warming up" slowly, or "soaking" the line, this method will no doubt seem dangerous, but the results obtained from close observation and actual test indicate that it is the best that can be followed.

The same phenomena take place in starting up a steam turbine. In the Parsons type of machine where the blade and clearances are small, the "warming up" method of starting is likely to cause blade failures, because when a machine is standing still, the spindle and cylinder "rainbow" in the same direction, but as soon as the spindle revolves one-half a revolution, the top of the spindle (then at the bottom), unless the clearances are large, rubs the bottom of the cylinder. The new method is to open the throttle quickly until the spindle starts to revolve, after which the throttle is almost closed again, allowing the turbine to revolve slowly until the heat is evenly distributed.

## PACKING VALVE STEMS UNDER PRESSURE

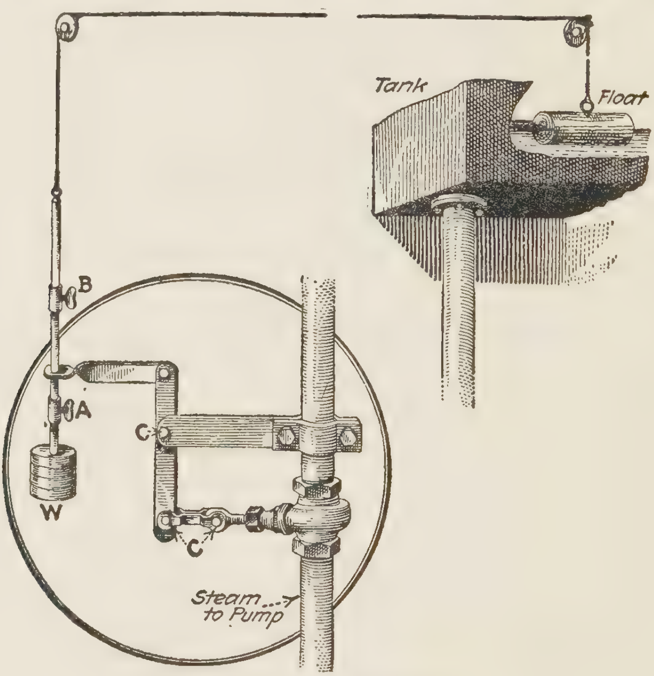
Packing a globe valve with the pressure coming above the valve disk can be easily done by taking a piece of band iron 3/8 in. thick, 3/4 in. wide and 4 ft. long and making a clamp of a size to get around the packing nut.

To pack the valve, first open it wide, so as to check the flow of escaping steam as much as possible from around the valve stem. Then remove the valve wheel and the packing nut. A piece of burlap may be thrown over the valve to baffle the steam.

The packing rings should be a loose fit around the valve stem and a tight fit inside the packing nut, enough new ring being used to fill the nut about three-fourths full. The clamp can then be tightened to the stuffing-nut for screwing it in place on the valve. The strap is then removed, and the operation need not take more than two minutes if everything has been made ready.

## FLOAT CONTROL FOR PUMP

The illustration shows a simple tank-pump float control. The float is a log heavy enough to overbalance the rod, weight and connecting

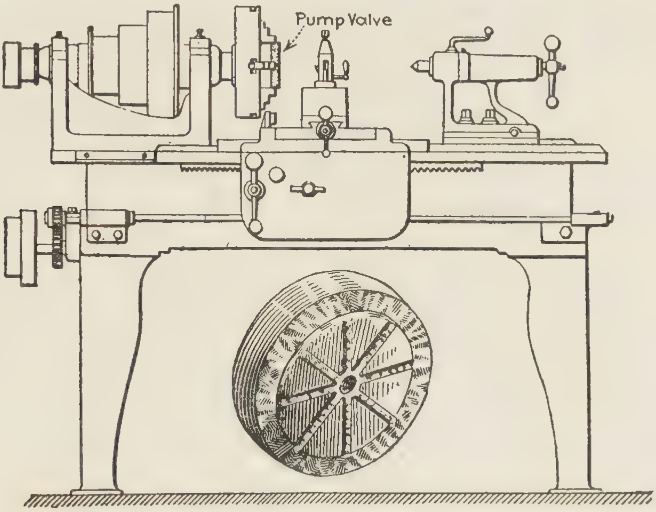



DETAIL OF VALVE GEAR

line. The limits *A* and *B* can be set so that the pump will not begin working until the tank is nearly empty and will stop when the tank is full or at any other point desired.

## REFACING PUMP VALVES

A wrinkle for refacing pump valves is as follows: Put them in a small lathe, turn them up with a facing tool and finish with a block




REFACING PUMP VALVE IN LATHE

of wood covered with No. 00 or No. 1½ sandpaper. This is quicker than handwork and makes just as good a job.

## RESEATING A GLOBE VALVE

A cheap way of reseating a globe valve is to simply tap the seat end of the valve all the way through and screw in a brass nipple until it protrudes about one-eighth inch. The end of the nipple being squared off, serves as the seat, as shown in Fig. 1.

The 2½-in. globe throttle valve of an engine leaked so badly that it was necessary to close the stop valve at the boiler in order to stop the engine. The seat of this valve was in such bad condition that grinding was out of the question. The only machine was a small hand-power blacksmith's drill press, which was bolted to a post. This was taken down and secured to a timber in a horizontal position, Fig. 2. One end of a piece of hardwood was cut down to fit into the drill chuck. A short block of wood, with a nail in it, was clamped in proper position and made to do duty as a tailstock center. Then with a man turning the drill press, this piece of wood was turned with a hand tool, one end being slightly larger than the valve seat, and its face beveled to

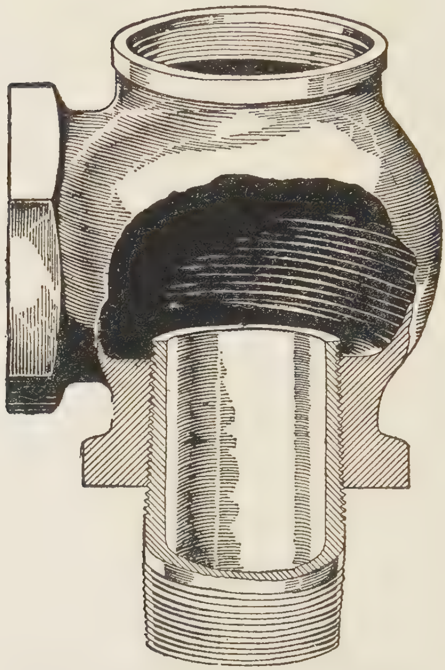


FIG. 1. NIPPLE FORMS VALVE SEAT

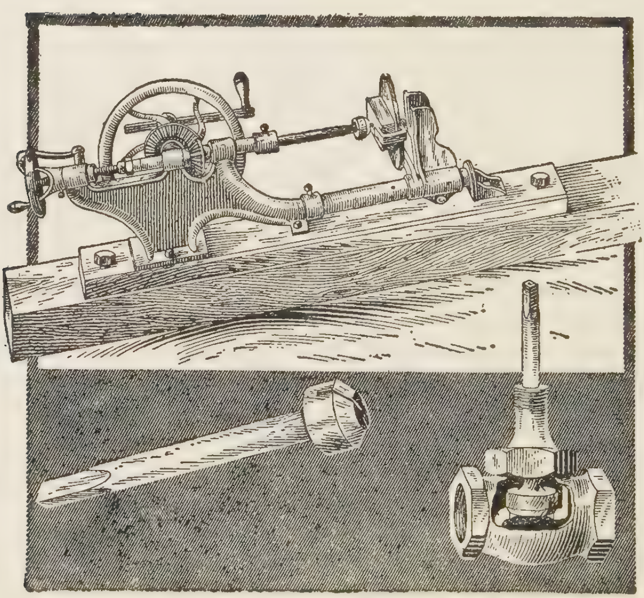


FIG. 2. AN EMERGENCY VALVE-GRINDING TOOL

an angle of about 45 deg. The rest of the stick was turned to fit loosely in the hole in the valve bonnet. This was to guide the tool and hold it steady. These details are shown in the upper illustration. A piece of hacksaw blade was then fitted into the 45-deg. bevel and tightly wedged in place, and was ground down on a grindstone almost to the wood, so as to give but little clearance, to prevent chattering. The tool is shown at the lower left side of the illustration. The application of the tool to a valve is shown at the other side.

The valve bonnet was then slipped on the shank of the tool and screwed into place. A lagscrew in the end of a piece of timber secured to the side of the mill furnished the feed, and by turning the tool with a wrench and feeding carefully with the lagscrew, the valve seat was soon machined in good shape.

Another short piece of wood was then held in the drill chuck and turned so the valve button would screw onto it, and with a man turning the drill press as before, the button was filed smooth, as it did not run true enough to turn it. A piece of emery cloth was burned on a shovel, and with the powdered emery thus obtained the valve was ground in the usual way.

## THROTTLE HAD TOO MUCH PLAY

A 1500-hp. cross-compound Corliss engine suddenly showed difficulty in taking care of the regular load of about 1000 hp. Indicator diagram *A*, Fig. 1, had been taken a few days previously, but card *B*


FIG. 1. TWO SETS OF DIAGRAMS FROM SAME ENGINE

was the best that could be obtained. The dropping steam line showed wire-drawing, a throttling effect on the steam, or the piston leaking badly.

Notes of the water used in the condenser showed no increase over previous days, and equally good vacuum eliminated the possibility of a faulty piston. A steam gage at the receiver separator near the throttle showed practically full boiler pressure, so the trouble evidently was at or near the throttle valve. This valve was one that opened away from the operating wheel, having a left-hand thread on the stem, Fig. 2. The stem also actuated the bypass.

The cover was removed from the valve and it was found that the

nut holding the valve disk in place had moved back to such an extent that the main disk remained on the seat when the stem had reached its limit, allowing only the steam that passed through the bypass to operate the engine, which was carrying about 66 per cent of full load.

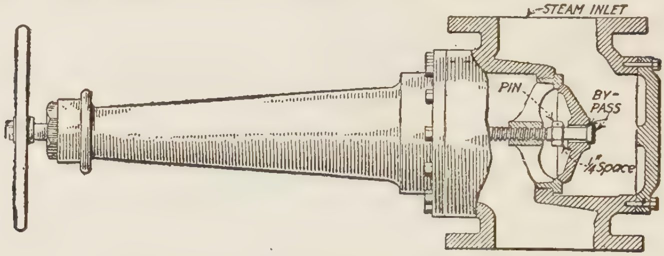
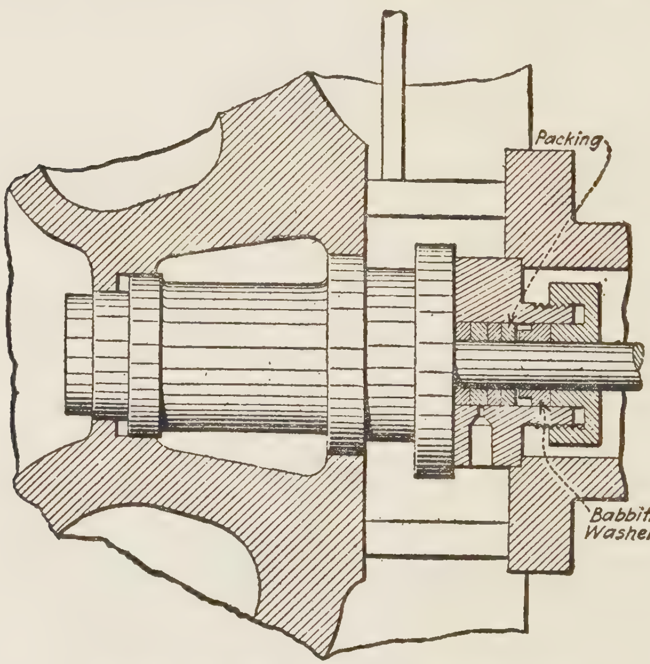



FIG. 2. TYPE OF VALVE THAT GAVE TROUBLE

## TROUBLE WITH SPRAY VALVE PACKING

Trouble with spray-valve packing on a semi-Diesel engine with closed tap valve may be had if the stuffing-box is not deep enough, as



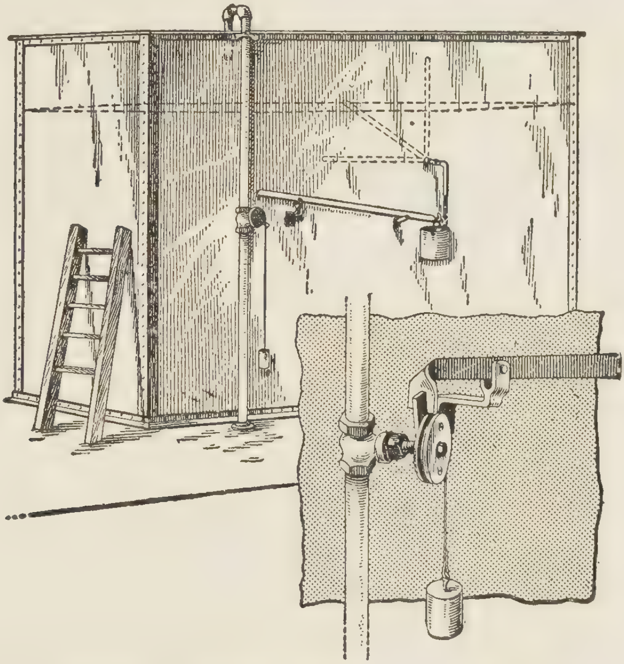

BABBITT WASHER APPLIED TO STUFFING-BOX

the shredded metallic packing used will work out around the outside of the gland enough to keep it from drawing up and keeping the packing tight on the valve.

To remedy this trouble cut a piece of babbitt 3/8 in. thick and large enough to cover the opening in the stuffing-box. Then drill a hole in the center of this the size of the spray valve and cut the piece down to a little larger than the opening and force it into the box so as to get a better fit on account of the box being badly scored.

## VALVE AUTOMATICALLY CLOSES WHEN TANK FILLS

The elevated tank in a certain plant had to be filled every morning for the day's supply, and the supply pipe was rather small. This meant

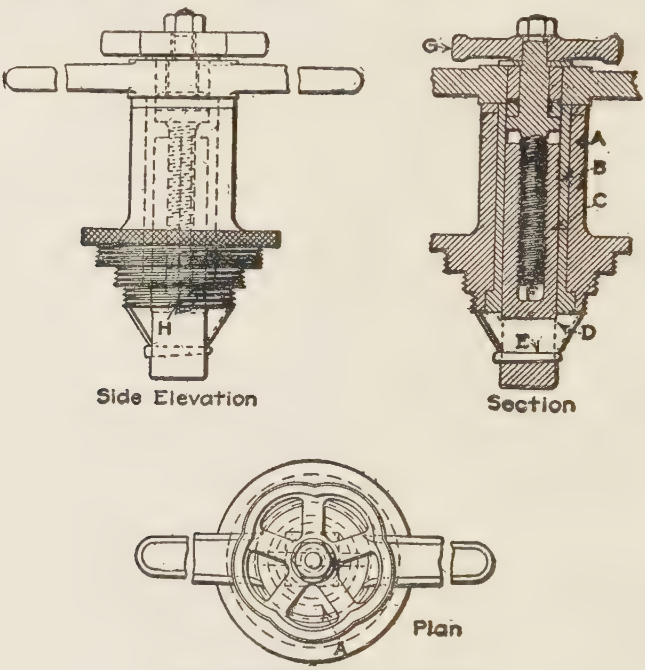


OVERFLOW RELEASES WEIGHT TO CLOSE VALVE

a long wait for the engineer while the tank was filling or a return trip, which was sometimes deferred a little too long and an overflow resulted. A different level was also desirable for different processes. The engineer rigged up the device shown in the illustration so that he could simply open the valve, set the stop against it and go about his other duties. When the tank fills to the point at which the small overflow is set, the pail partly fills and trips the catch and the suspended weight closes the supply valve.

## VALVE-RESEATING DEVICE

A valve-reseating device which was designed to reclaim a number of old globe valves and which should be found generally useful is shown in the illustration. Its operation may be described as follows: The sleeve *B* revolves in the body *A,* and the spindle *C* slides in *B* and is splined from the cutter *D* to the upper end. The sleeve *B* has a driving key *H,* which carries the cutter. The spindle *C,* with the cutter *D,* is




VALVE RESEATING DEVICE

raised or lowered by the screw *F,* actuated by the wheel *G.* The cutter is gibbed to fit the spindle and is held in place by the key *E.* The body *A* is threaded to fit three consecutive sizes of valves; the one shown handles 2, $1\frac{1}{2}$, and $1\frac{1}{4}$ in. A separate cutter is required for each size of valve.

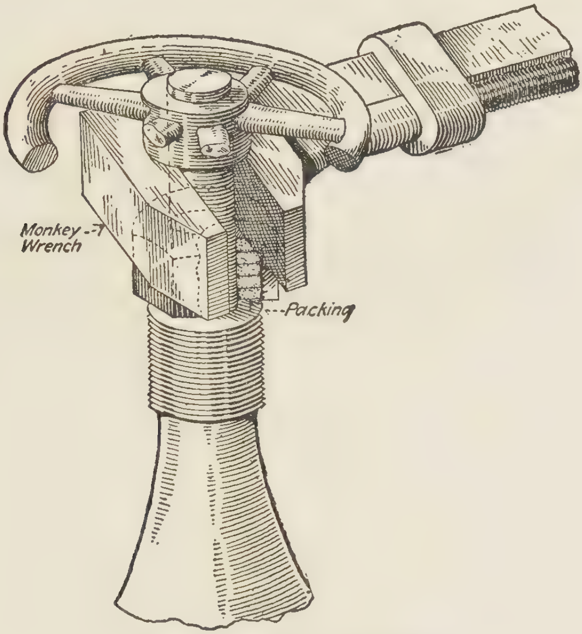
To use the device the valve bonnet is unscrewed and removed, and the reseater screwed into its place. The cutter is fed by the wheel *G* and revolved by the handle until a sufficient cut is made. The valve need not be removed from the pipe line.

A minor drawback to the device is that it will fit valves of only one particular brand; that is, those that have the bonnet threaded to

one standard range of sizes. The cost of making the reseater is small, however, and it is paid for when one valve of each size is reclaimed.

## VALVE-STEM PACKING KINK

When packing a gate or a globe valve, using a packing nut that screws onto the neck of the valve bonnet, it is sometimes difficult to start the nut on, if it is well filled with packing. This difficulty may




SCREWING ON A PACKING NUT

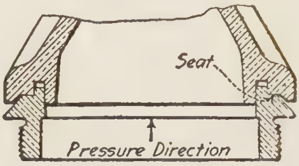
be avoided by opening an ordinary monkey wrench a little wider than the diameter of the valve stem, and placing it over the stem between the valve wheel and the packing nut, as shown. If the valve wheel is then turned until the nut is brought up to the threads on the valve bonnet, and the nut is turned at the same time, it will start on easily and there is plenty of packing around the stem.

In case the distance between the nut and the valve wheel is too great to permit the use of a monkey wrench, a piece of wood of the proper thickness may be used.

## WATER-COLUMN BLOWOFF VALVE

Water-column blowoff service is similar to boiler blowoff service in that it is a valve that is subject to extreme temperature changes and the passage of a certain amount of grit and dirt over the holding faces.

A blowoff valve with a protected seat and disk, as illustrated, would




DESIGN OF DISK AND SEAT

solve the problem and, if used, water-column blowoff difficulties will be vastly decreased.

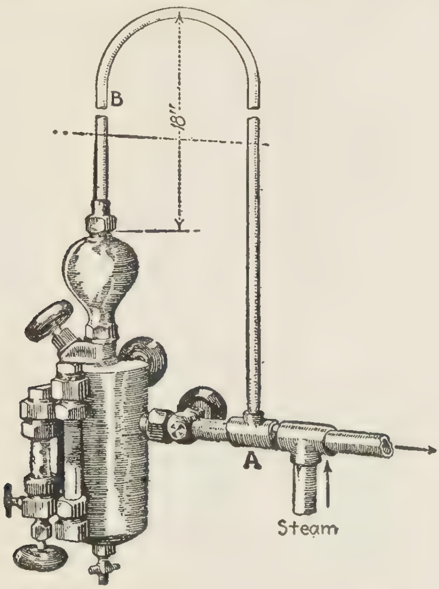
It is particularly suited to take care of the differential expansion between the internal and external parts of the valve. Therefore, when this valve cools, the disk is really pressed tighter to the seat than when closed off while hot, thus insuring against this seat lifting when cooling down.

## *SECTION V*

# LUBRICATING KINKS

### CHANGING A DOUBLE-CONNECTION TO SINGLE-CONNECTION LUBRICATOR

THE illustration shows a standard double-connection lubricator, changed to be used as a single-connection lubricator. It was used on the steam-extraction gear of a steam turbine, and as the steam line came in from below, there was no overhead line to tap in on.

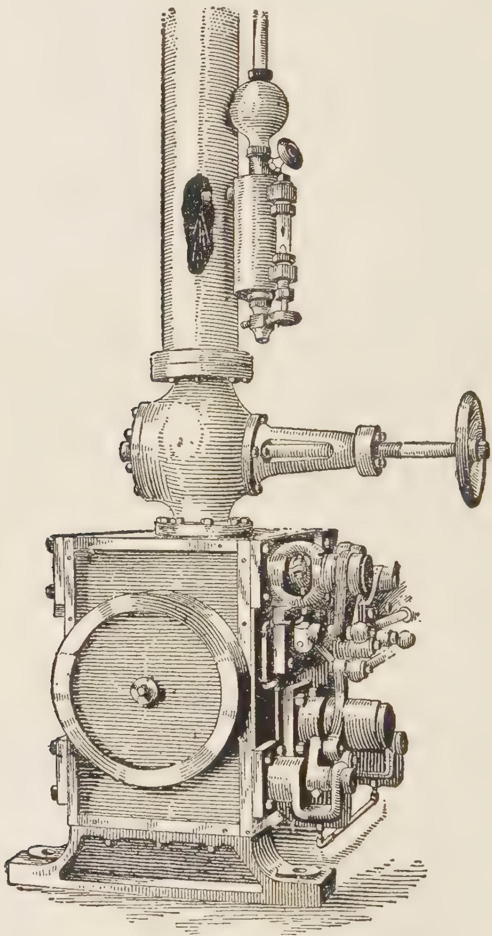



CONNECTION ON LUBRICATOR

The ½-in. by ¼-in. tee *A* was used as shown. A ¼-in. pipe was put in from this tee to the water chamber, this pipe being 18 in. above the top of the water chamber of the lubricator. This gave a sufficient head of water in the leg *B* of the pipe.

## CHANGED THE LUBRICATOR PIPING

When a drop of oil disappears up the sight glass of a lubricator, it does not indicate that the oil goes where it is needed, and the engineer must decide by the running of the engine as to whether it is being



CHANGED LUBRICATOR OUTLET

properly lubricated or not. In one instance the lubricator connection to the steam pipe was held with but two threads. The oil was running down on the inside of the pipe and not mixing with the steam, so that the head-end of the cylinder was getting practically all the oil and the crank end none. A bushing was reduced from $\frac{1}{2}$ to $\frac{1}{8}$ in. and a $\frac{1}{8}$-in.

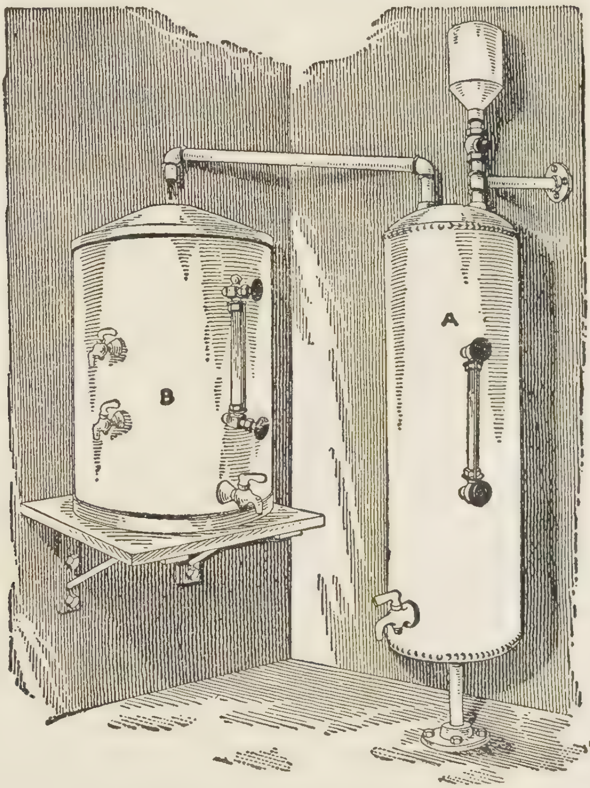
nipple screwed through it long enough to reach to the center of the inside of the pipe above the throttle valve so that the oil could always mix with the steam going to the cylinder.

## CORRECT LOCATION FOR CYLINDER-LUBRICATOR PUMP

Three cylinder lubricators, of the pump or force-feed type, gave trouble by getting hot and failing to work until cooled down. The difficulty was overcome by lowering the pump one-half inch below the discharge into the cylinder so that there is oil in the lower part of the pipe at all times and the steam cannot get back into the pump.

## EASILY MADE OIL FILTERS

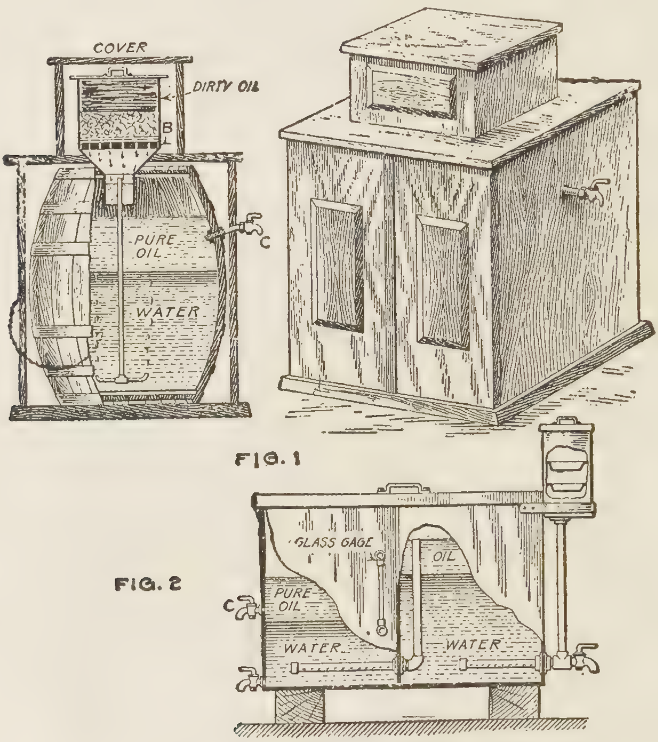
An oil filter that is a little out of the ordinary and that can be easily made is shown in the illustration.




OIL-WASHING TANK RELIEVES FILTERS

Tank *A* is a 30-gallon range boiler and *B* is a small oil filter. Tank *A* is filled about half full of water. The used oil is poured into the

funnel at the top, which holds about three gallons, and flows slowly down the pipe extending inside of the tank to the bottom similar to the cold-water pipe in a range boiler. The cock is partly closed to regulate the flow. The oil then passes up through the water to the overflow pipe at the top of the tank, during which time the water washes out the foreign matter and cleanses the oil. The drain-cock at the bottom of tank *A* is opened at intervals and the sediment flushed off and clean water added at the top. It is necessary to clean the second filter




TWO FORMS OF HOME-MADE OIL FILTERS

only at long intervals and clean oil is assured with little attention. It could be improved by means of pumps to handle the oil automatically.

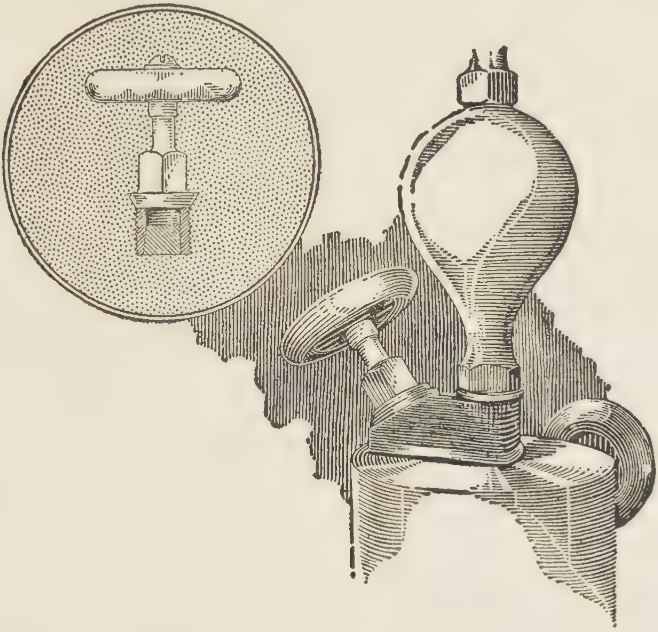
An oil filter may be made by obtaining a sound oil barrel with a receiver, set into the head, as shown in Fig. 1, made of galvanized iron, or even an empty 25-lb. cup-grease can, will do good work. A pipe is attached, in any convenient way, to the bottom of the receiver and extended nearly to the bottom of the barrel, which is about half filled with water kept warm to expedite the action. The perforated bottom *B* in the receiver holds several thicknesses of burlap and some clean

waste. Clean oil is drawn off at *C*. The filter may be partly or wholly inclosed in a cabinet if desired.

A little more elaborate filter may be made as shown in Fig. 2, of galvanized iron.

## EMERGENCY REPAIR TO LUBRICATOR PLUG

The threads on the filling plug of a lubricator became so badly worn that the plug would not hold owing to countless removals and insertions which had blunted the threads. A hole was drilled in the end of the plug to a distance a little beyond the threads, leaving a fair

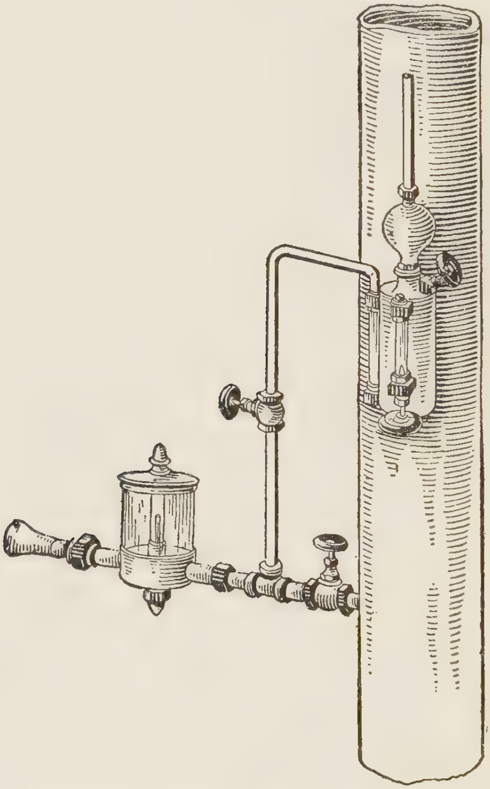


PLUGGED THE LUBRICATOR FILLING PLUG

amount of stock. A taper pin was filed and driven into the hole to expand the lower end of the plug, thus enlarging the threaded portion. After being expanded until it was a snug fit in the threads in the body, the pin was driven in and the end of the plug peened slightly to hold it in place. Although the threads were worn, the enlarged plug worked very well for some months until the engine was no longer needed. Then the plug was sent to a machine shop for proper treatment.

## HANDY LUBRICATOR KINKS

Almost all engines and steam pumps have, and all should have, a hand oil pump to be used in case of emergency. By inserting a tee and valve between the pump and steam pipe and connecting a pipe from the tee to the top of the lubricator reservoir, as shown in the illustration, the pump can be used to fill the lubricator. Or by closing



LUBRICATOR FILLED WITH A HAND PUMP

the valve to the lubricator and opening the one to the steam pipe, oil can be pumped directly into the steam pipe whenever desired.

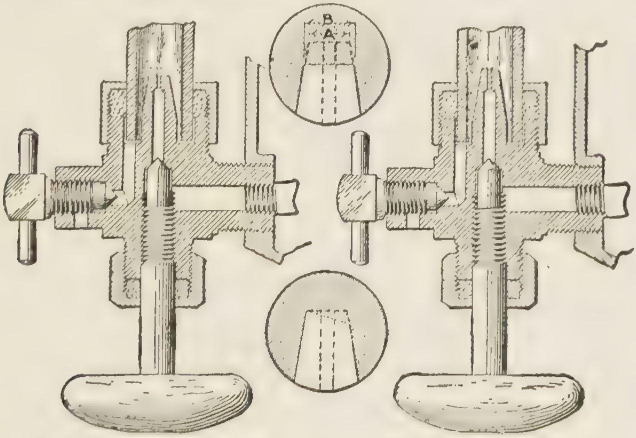
To fill the lubricator it is not necessary to drain the reservoir or disturb the valves unless it is found that the impulses from the pump soil the feed glass, in which case simply check or entirely stop the feed while filling. When oil is pumped into the top of the reservoir, the water is forced from the bottom up through the condensing chamber and pipe into the steam pipe and passes out through the engine. By

this means there is no necessity for a drip pan, waste or wrench, as the lubricator remains closed and clean and not a drop of oil is wasted. If the lubricator should run dry and hot, as they sometimes do, close the feed valve to keep the feed glass clean and pump in the oil. This will force any water that may be left in the lubricator out of the reservoir and into the condensing chamber where it is needed, thus putting the lubricator in condition to begin feeding without loss of time, spattering of oil or burnt fingers.

A combined hydrostatic and mechanically operated lubricator arrangement can be made by securing an inexpensive force-feed lubricator pump, without a sight-feed glass, and connecting its discharge pipe to the top connection of the oil-reservoir glass of the hydrostatic lubricator in the same way as shown for the hand pump. By closing the steam valve in the condensing pipe and opening the feed valve wide, the oil pump fed through the sight-feed glass where it can be observed much better than in most force-fed lubricators. If the pump should fail, the lubricator can be turned on in a moment by opening the steam valve on the condensing pipe and regulating the feed.

## HYDROSTATIC LUBRICATOR REGULATION

The size of the oildrop of a hydrostatic lubricator may be varied by slightly changing the end of the nozzle. If a larger drop is desired, file off the end of the nozzle as shown in the first illustration.




FILING THE NOZZLE OF SIGHT-FEED LUBRICATOR

This gives a greater area across the end as at *B* for the same size of opening in the nozzle, and the result is a larger drop. The reason for this is that a drop of oil forms on the end of a pipe or nozzle because

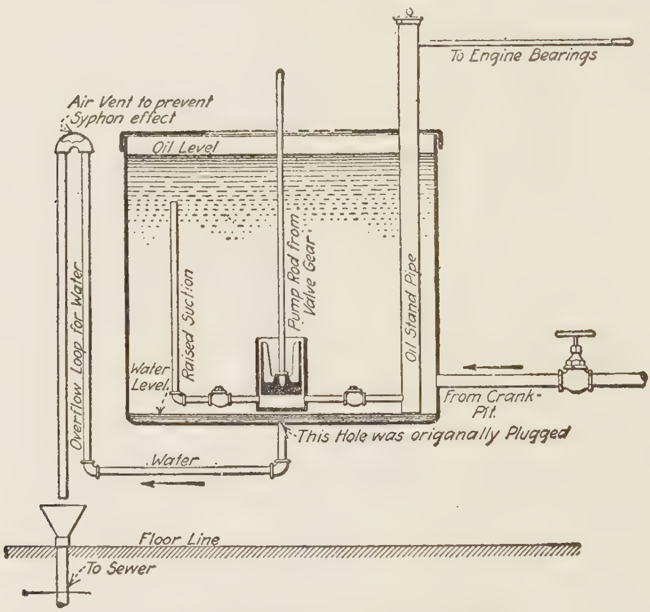
of the adhesion between the oil and the metal on the end. The drop breaks off and floats up through the water because the buoyancy becomes greater than the adhesion. With more surface at *B* for the oil to adhere to than at *A* more buoyancy, and hence a larger drop is needed before it will break off and float upward.

When a smaller drop is desired, it is a simple matter to file the end of the nozzle to a sharper point so that less surface remains on the end.

Care should be taken to file the nozzle evenly. If filed unevenly, as shown in the second illustration, the drops will travel up at an angle, hit the glass and follow it, and thus soon fill the sight glass with oil.

## IMPROVES AN OIL SYSTEM

The sketch shows some improvements made to an oiling system. The engine came equipped with an oiling system as shown. The suc-




IMPROVEMENTS IN OIL SYSTEM

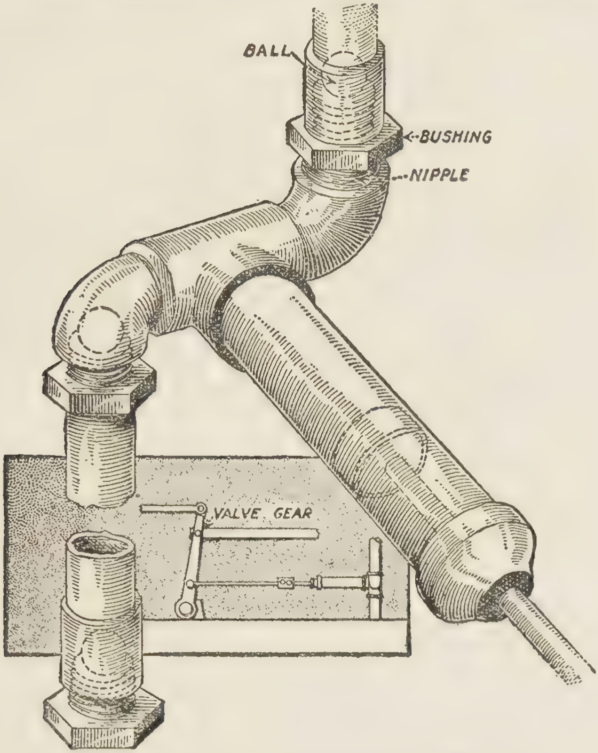
tion of the pump caught all the water and sediment and soon made an emulsion of the whole oil-tank contents. Every little while it was necessary to change the oil, filter and separate out the old oil in a separate apparatus.

The suction opening was raised and the complete overflow added. The water now flows out over the loop, carrying with it the sediment

that settles to the bottom, while the raised suction gets the pure, best oil from near the surface.

## LARGE SAVING BY RE-USE OF OIL

In one plant the oil flowed to the flywheel pit, which was drained through a 2-in. pipe. A pan was made to be set under the outlet end of this pipe; then with a few fittings a pump was made to take the oil from the pan and discharge it into the filter. The pump was made out




OIL PUMP ATTACHED TO VALVE GEAR

of a piece of tube three inches long, three brass bushings, one brass tee and three steel balls from an old automobile wheel, two street ells, two couplings and one close nipple; it is driven from the valve gear.

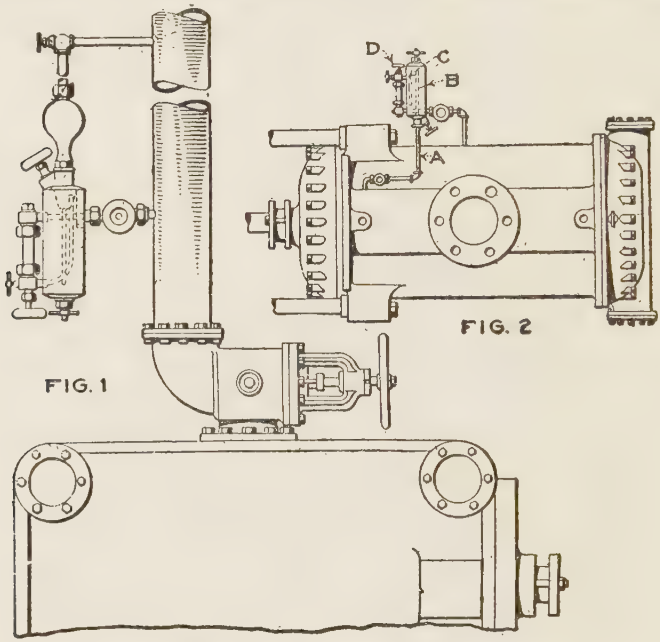
## LUBRICATING AN AIR COMPRESSOR

Considerable trouble was had with the valves carbonizing and getting hot on a new air compressor. An oil pump was connected to the air cylinder. It was then filled with water and a few drops of water

were fed per minute to the cylinder. This stopped the valves carbonizing or getting hot and resulted in a saving in oil.

## LUBRICATOR ON AIR COMPRESSOR

In moving a large air compressor, the lubricator was accidentally broken and damaged beyond repair. When the piston was taken out, the cylinder and piston were found to be badly scored owing to lack of oil. An old hydrostatic lubricator was found about the place, and Fig. 1 shows how it is connected up for use with steam, and Fig. 2




OLD AND NEW CONNECTIONS OF LUBRICATOR

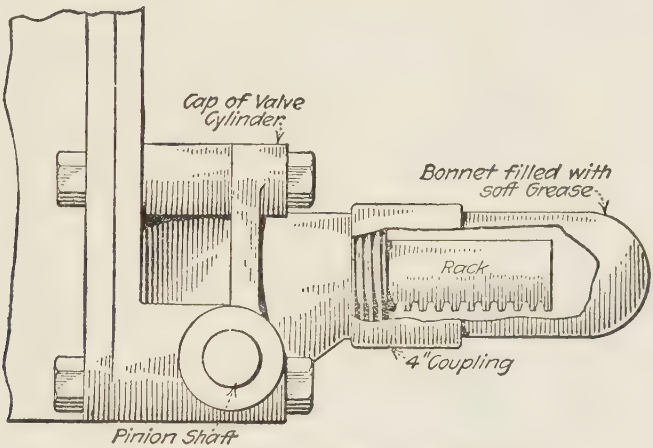
shows how it is rigged on the air cylinder. The condensing chamber was taken off and the lubricator turned upside down and a connection from the discharge side of the compressor hooked in where the condensing chamber had been. The feed connection was turned down and connected into the top of the cylinder at midstroke.

The action is as follows: The air pressure enters from the discharge manifold, through the pipe *A* and tube *B* to the top (originally the bottom) of the lubricator and forces the oil out through the tube *C*, needle valve *D*, and on through the sight-feed glass and discharge tube into the compressor cylinder. The operation is positive from the fact that there is always an unbalanced pressure between the two connec-

tions because the compression pressure has only risen to about half the discharge pressure when the piston passes the discharge connection of the lubricator at midstroke, and from this point to the end of the stroke there is suction on this connection and there is always discharge pressure on the other connection.

## LUBRICATING RACK-AND-PINION GEARS

The accompanying sketch shows a device for lubricating the rack-and-pinion gears that shift the operating valves of a pair of horizontal-cylinder hydraulic elevators. The racks are made of steel and the




RACK-AND-PINION GEAR LUBRICATOR

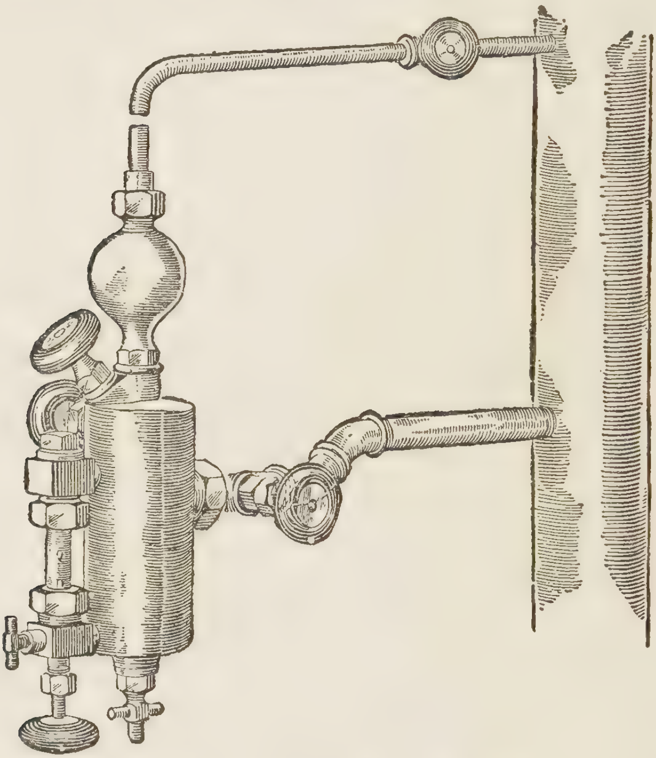
pinions of brass. In the original design of the machine no provision was made for getting oil to the meshing contacts of the gears in the horizontal position. On this account the wear of the pinion was excessive, necessitating frequent renewals. To correct the cap of the valve casing was threaded to receive a 4-in. pipe coupling having a cup-shaped grease receptacle attached as shown.

## STARTING THE OIL TO RUN

Frequently, when an engine is to be started and the oil is set to flow on the crank, instead of flowing in a stream it comes out of the cup in drops. One method of starting it to flow in a stream is to place a finger in the sight hole, letting the oil drop on the finger nail and then lift the finger until the oil begins to come in a stream. Then lower the finger, pulling it away quickly, and the oil will then run in a stream.

## PROTECTING LUBRICATOR GASKETS

The following shows how trouble with lubricators was overcome. The illustration shows the connections that were used to prevent the top gasket of the sight-feed glass from softening and squeezing out on the stuffing nut. Instead of connecting the lubricator feed pipe direct to the steam pipe, as is the general practice, use two 45-deg. elbows



CHANGED PIPING TO THE LUBRICATOR

and a close nipple. This arrangement holds the condensation between the lubricator and the ell nearest the steam line and so prevents steam from coming in direct contact with the lubricator, thus preventing overheating of the top gaskets.

## USING COMPRESSION GREASE CUP AS WICK-FEED OILER

How an ordinary pressed-steel or brass screw grease cup may be made into a wick-feed oiler similar to the type used on small electric motors is shown in Fig. 1. This has the advantage of a larger oil container than is usually supplied. The base should be drilled out smoothly,

if there are any burrs present, and a round felt wick cut to fit the hole snugly but so that it will move freely. A tapered spring is made of brass spring wire with a large-diameter base to fit the cap of the grease cup. This is attached to the wick as shown in Fig. 2. To use as an underfeed oiler, it is only necessary to adjust the wick and spring

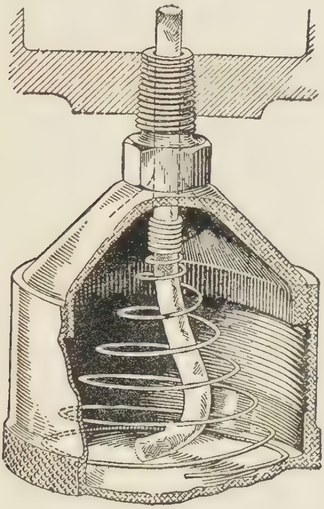


FIG. 1. WICK FEED OILER MADE FROM GREASE CUP

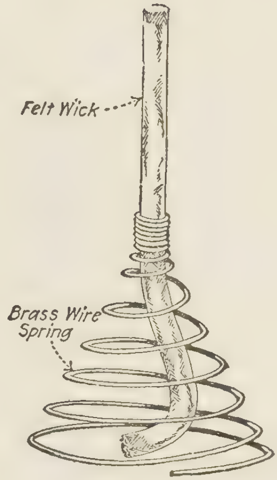



FIG. 2. METHOD OF JOINING SPRING AND WICK

so that the former will project about a quarter of an inch from the nipple when the whole cup is removed from the bearing, filled with oil and screwed into place.

To use as an overfeed boiler, the cup should be packed with waste and the wick used without a spring, adjusting its pressure on the bearing by screwing down on the cup. The waste will retain the oil in this case, provided the cup threads make a fairly good fit on the base; if too loose, the threads on both cup and base may be coated with shellac and this allowed to become hard before screwing together.

## FLASH AND FIRE POINTS

The "flash point" of an oil is that temperature to which the oil must be heated, at a specified rate, so that enough vapor is freed from its surface to ignite when a flame is applied to it. The "fire test" is that temperature to which an oil must be heated, at a specified rate, so that it takes fire and burns continuously, when a flame is applied to its surface.

## OIL AND GREASE TRAP

Considerable oil can be saved in the course of a year in many plants if all drains or drips that contain any oil at all are intercepted before

OIL INTERCEPTED ON ITS WAY TO THE SEWER (See page 81)

being discharged to the sewer by some such a grease or oil trap as that shown in the illustration. The construction of the trap is simple and inexpensive and its operation is satisfactory.

*SECTION VI*

# KINKS IN PIPES AND PIPING

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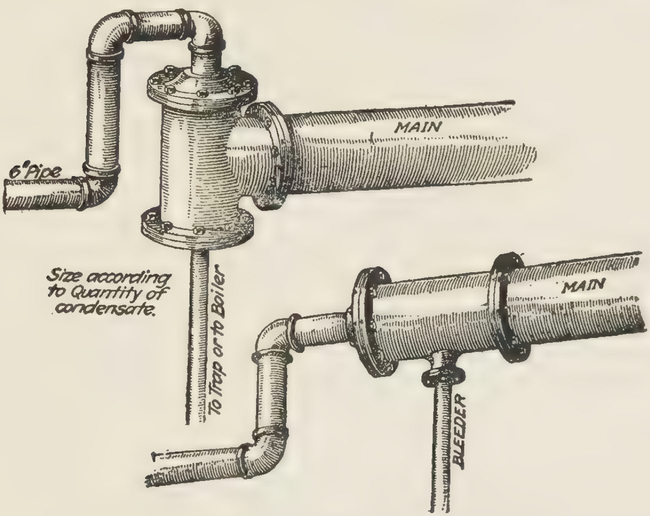
## DRAINING HEADER PIPING

Two methods of draining a header are shown herewith: Put in a flanged tee with the run vertical or horizontal according to the avail-




TWO METHODS OF PIPING BLEEDER PIPE

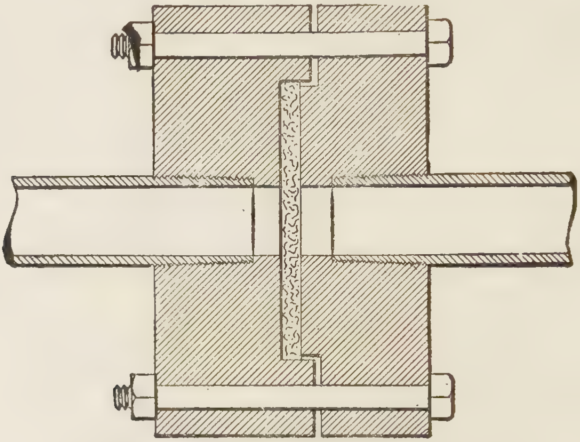
able space, as shown. This makes a proper connection of the bleeder pipe to the tee.

## AN EMERGENCY UNION

Extra heavy fittings for extremely high pressures are sometimes hard to get, and unless they are carried in stock a break in a line of this kind is likely to cause worry, as well as delay in the operation of the machinery depending on the line. In one instance a union on a

$1\frac{1}{4}$-in. hydraulic line, carrying 3500 lb. pressure, broke, and as there were none in stock, a new one had to be devised.

A piece of scrap shafting about 4 in. in diameter was secured and two pieces were sawed off about $1\frac{1}{4}$ in. thick. These were placed in a lathe, faced off, bored and threaded to fit the pipe. They were then chucked with the other side out, faced and one made female and the



CROSS-SECTION THROUGH THE UNION

other male, as shown. Four half-inch bolt holes were then drilled in each half of the union to match. A sole-leather gasket was made to fit into the cavity in the female half, and the job was finished.

## "DOPE" FOR PIPE JOINTS

Putting white lead on the inside of pipe fittings is found to be the most satisfactory. Graphite mixed with cylinder oil put on the inside of the fittings is also satisfactory.

## DOUBLE DISCHARGE INTERNAL FEED PIPES

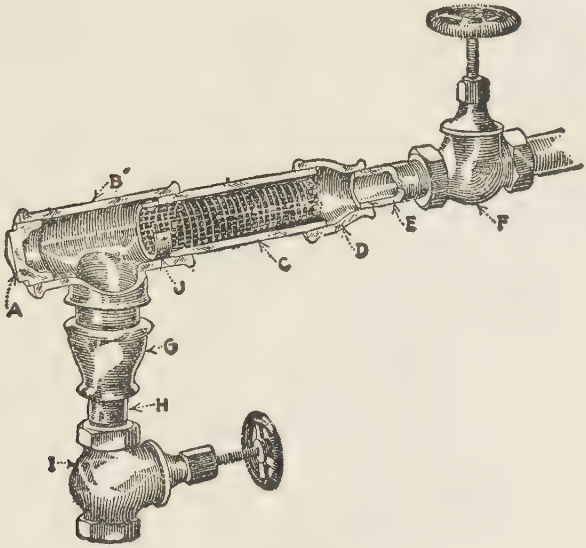
Trouble with feed-water pipes stopping up with scale inside of the boilers is not uncommon, and may cause a shutdown. To prevent this trouble, put a tee on the end of the internal feed pipe, with a pipe projecting to each side of the boiler, making an outlet two ways and two $1\frac{1}{2}$-in. discharge openings instead of one.

## A GOOD WATER-LINE STRAINER

A good cheap strainer, to be used in water lines, can be made from a housing of pipe fittings. For a 2-in. water line use a 4-in. plug *A* and tee *B*, 4-in. nipple *C*, reducer from 4 in. to 2 in. *D*, 2-in. nipple

*E*, 2-in. globe valve *F*, bushing *G* from 4 to 2 in., 2-in. nipple *H* and a 2-in. globe valve *I*.

First select some galvanized screen wire, with suitable mesh for the desired results; for instance, about $^3/_{16}$-in. mesh for feed water going to the open heater, and cut a piece 7 x 23 in. The idea of cutting the screen wire 23 in. long is in order to give it double strength. Then roll it up so that the top end is a little less in diameter than the 4-in. nipple at the top end, and the bottom end about ¾ in. less in diameter, so as to give the water a chance to flow through the outside of the strainer as well as out at the bottom.




DETAILS OF STRAINER

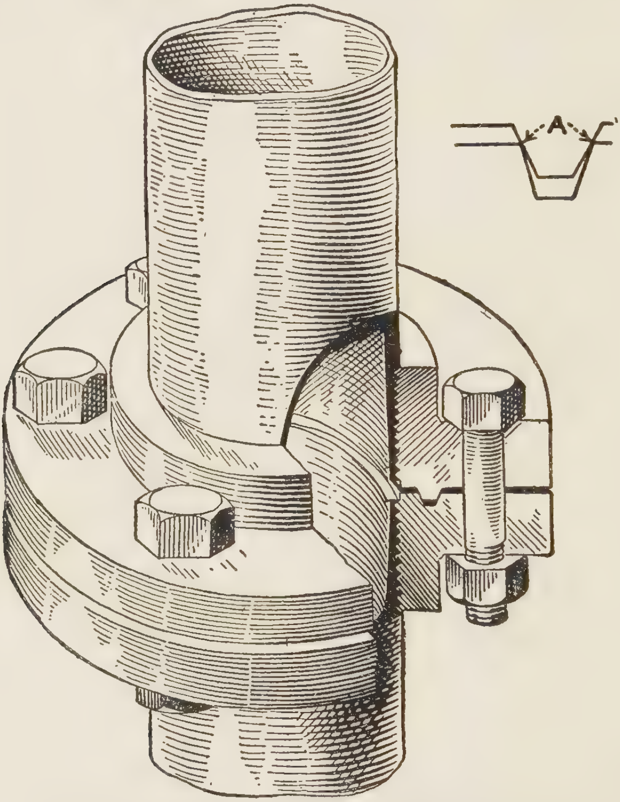
With the strainer body rolled to the proper size, tie a cord around it to hold it in position; then make a band for the top end, about ¾ in. wide by ⅛ in. thick, with holes drilled all around, about one inch apart. Place this band over the end of the strainer and copper rivet it through the mesh of the strainer, and also rivet along the side. Next, cut a piece of the screen about 1½ in. larger than the diameter of the bottom end of the strainer, nick the edge with a pair of snips so that it can be turned up about ¾ in. all around, insert on the top end of the strainer and rivet with five or six copper rivets.

It is necessary to have a bail for the removal of the strainer for cleaning, etc. Make the bail from a piece of 12-gage wire, the ends hooked through two extra holes that are drilled in the band for that

purpose. The bail should be long enough to reach close up to the plug. To insert or remove the strainer, just take out the plug. The strainer should pass on through the tee *B*, and into the 4-in. nipple with the edge of the band *J* snug against the end of the 4-in. nipple *C*, as shown.

## A METAL-TO-METAL FLANGE JOINT

If flanges give trouble from blowing packing, put the flanges in a



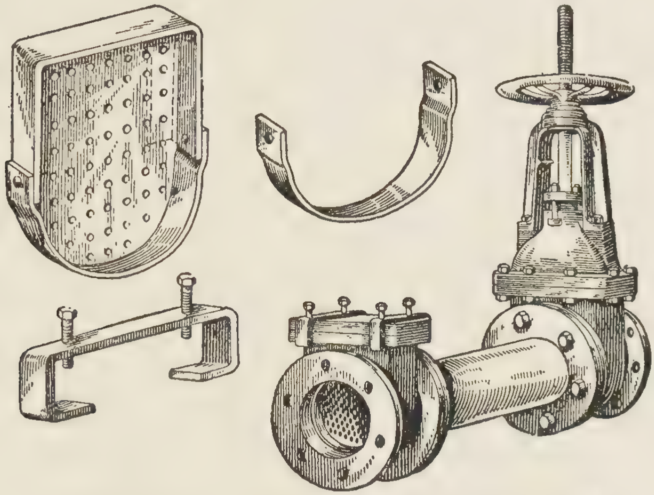

SPECIAL PIPE FLANGE FOR A DIFFICULT PLACE

lathe and turn a tongue and groove, as shown, so that a tight metal joint is made at the points *A* in the enlarged view.

## SCREEN FOR SUCTION LINE

The 6-in. suction line of a pump supplying cooling water for a gas engine sometimes got choked up. To remedy this trouble a strainer was put in the body of an old 6-in. gate valve, as shown, and connected into the suction. The strainer was made of ⅛-in. sheet iron, shaped

to fit into the groove originally occupied by the gate, drilled full of $^5/_{16}$-in. holes. An angle frame formed to the shape of the space was riveted on to stiffen the strainer and catch the leaves when the strainer was withdrawn for cleaning. The cover and clamps for holding it down are shown.



STRAINER TO GO INTO BODY OF OLD GATE VALVE

To clean the strainer, the pump is shut down and the valve closed, clamps and cover plate are removed and the strainer lifted out, all of which is easily and quickly accomplished.

## STEAM-HEADER POINTERS

The size of a steam header will depend on the velocity of steam desired. The velocity for saturated steam averages about 6000 ft. per min. when reciprocating engines are used, but where the steam has a steady flow through the line without pulsations, as in the case of a turbine, or when used for heating or industrial purposes, the velocity may safely be as high as 8000 or 9000 ft. per min. When large receivers are provided near each engine, the steam velocity to the engine may be increased to 7000 ft. per min. Advocates of high velocity maintain that in all cases economy dictates velocities 25 to 33 per cent higher than those given. A good rule is to make the steam-header area equal to the sum of the area of the full-size boiler outlet, and this can be followed to advantage in all except complicated layouts, or in the case of extremely long headers where there is no possibility of the header having to pass the full quantity of steam generated by the boilers, in which case a smaller size can be used.

Connections to and from the header should be as short and direct as possible consistent with proper provision for expansion, and sharp turns should be avoided. The line from each boiler to the header should be fitted with a stop valve and also with an automatic nonreturn valve to prevent the escape of steam in either direction in case of a rupture in the boiler or piping. The connections from the boilers should be made into the top of the header and long-turn bends or sweep elbows used in preference to standard tees or short elbows. The connections to engines should be taken off the top of the header so that any water in the steam will be left behind in the header to be taken care of by the drainage system.

It is customary to place the header above, or else back of the boilers where headroom is available. The practice of running the header along the front of the boilers is not to be recommended. Where the engine room adjoins the boiler room place the header inside the engine room, above the engine level, supported by brackets on the wall. It is not good practice to put steam headers in trenches or pits because of inaccessibility.

All connections to and from the boilers and engines should enter the header at the top to insure that any water that may collect in the header will not to picked up and carried to the engine. The header should be fitted with one or more drains of ample size, connected to high-pressure traps. It is not good practice to pitch the header in order to facilitate drainage from one point, since this might result in a large volume of water collecting at some low point and being carried over in a slug with the steam. Where the header is of considerable length the drain connections should be tapped at each end and at the middle if necessary. Each drain should be independent of any other and should be fitted with its own trap and bypass. For steam-header drainage a drain pipe not less than 1 in. should be used. Where large quantities of water may find their way into the header, it is advisable to set a drip pocket into the header at the drainage point or points so that any entrained water will fall by gravity out of the flow of the steam and be taken away by the trap.

For steam pressures up to 150 lb. and no superheat, steel pipe with cast-iron fittings should give satisfaction. Where superheated steam or any steam pressure over 150 lb. is encountered, cast-steel fittings should be used throughout. Metallic gaskets or special high-pressure packing material should be used on all joints.

Expansion and contraction of the header and of the inlet and outlet connections makes it essential that the header be left free to move in any direction, and it is usually best to support the header by chains

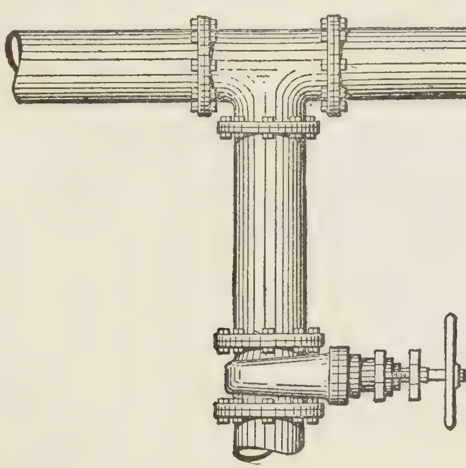
or on brackets fitted with rollers and expansion springs so that it is free to move in any direction made necessary by the strains imposed upon it. Otherwise, if firmly anchored, the expansion strain is certain to cause leakage, and even rupture might result from the constant strain imposed upon the metal.

Vibration of a header or other pipe line is usually due to one or two causes—mechanical vibration communicated from the engines, or vibration produced by pulsations in the flow of steam. The former can be overcome only at the original source of trouble, the engine. The latter indicates faulty design and construction of the steam lines or irregular operation of the engine. When it is found that the pipe line is really too small for the work, the vibration may frequently be allayed by the use of receivers in the pipe line, preferably near the engine.

All headers and steam lines should be well covered with insulating material to prevent heat loss. Experiments have shown that each square foot of bare pipe surface will radiate about 3 B.t.u. per hour for each degree difference between the temperature of the steam and that of the surrounding air.

## SETTLING CHAMBER IN PIPE LINE

Sometimes small stones will clog the volute type pump impeller and reduce the openings. To prevent such a difficulty cut the intake line

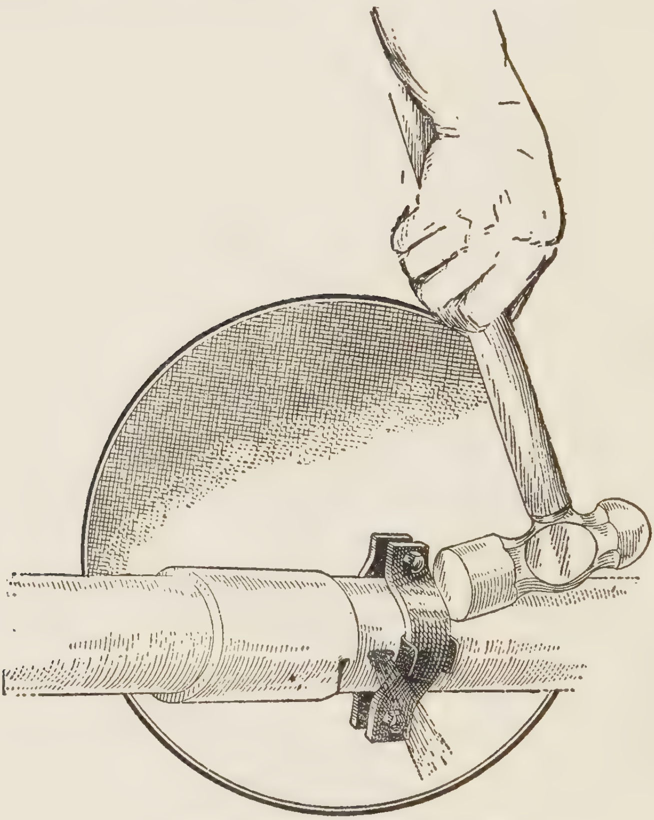


a short distance from the pump and put in a tee, as shown in the upper part of the illustration, with a 12-in. drop pocket and a gate valve on the end, forming a chamber on the intake line into which any heavy

foreign substance will fall. By blowing down once occasionally the trouble can be done away with.

## STOPPING LEAK IN ELEVATOR PIPING

The 8-in. main pipe that carries the water, under 300 lb. pressure, from the compression tank to the elevator cylinders suddenly began to



HAMMERING THE CLAMP IN PLACE

leak. The engineer on watch took two pieces of 2 x ⅝-in. flat iron that were handy and hastily forged them into the form of a band, punching the bolt-holes on the anvil, instead of drilling them, to save time. These were clamped around the pipe, over a liner of sheet copper which was turned up at the edges, and the tightened clamp was driven over the hole with a hammer, as indicated in the sketch. This improvised arrangement held, with considerable leakage, until the close of

the day, when the copper liner was taken out and a piece of sheet rubber substituted.

## THREADING A SHORT PIPE

To thread a pipe close to a bend or to thread a close nipple, reverse the dies in their sockets and use the stock in the reverse position but rotated in the right direction. This leaves no guide for the die, so to provide this use a short pipe of the size being threaded, having a good thread on one end, and insert it through the guide or follower and screw it into the die to act as a support. This can be held straight while the stock is turned and the thread started. When a few threads have been made, remove the guide pipe.

If plenty of oil is used, an excellent thread can be cut. Care should be taken to pull evenly on both handles or sides of the stock.

## VARIOUS TYPES OF PIPE HANGERS

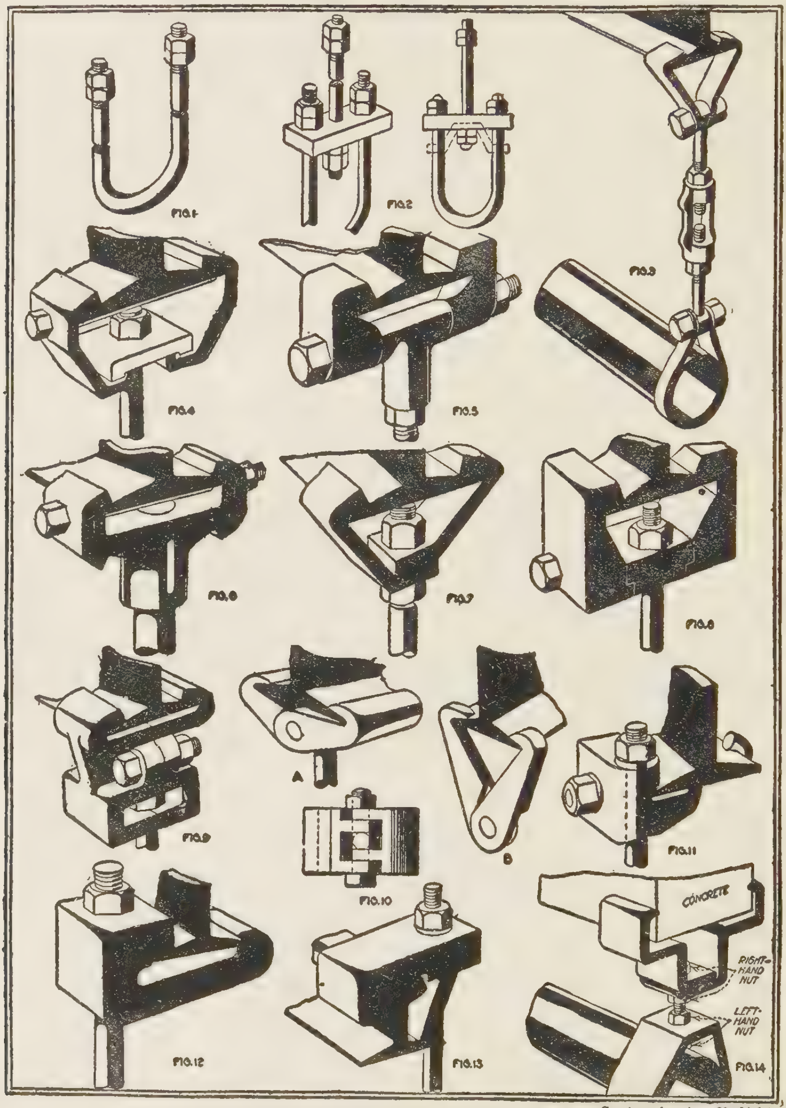
The common U-bolt, as shown in Fig. 1, forms about the simplest and cheapest pipe hanger when there exists a suitable structure overhead for attaching it. The rod should be threaded for a considerable distance on each end for adjustment, and for pipes subject to vibration, such as steam, exhaust, hydraulic-pressure lines, etc., there should be jam nuts or other form of nut locks. Where the distance to the joint of support is excessive, or the overhang structure favors attachment at a single joint, the pipe hanger in Fig. 2 is suitable. If a flat bar is used for the crossbeam, it should be bent as shown in dotted lines.

Fig. 3 illustrates a complete hanger with clamp suitable for attachment to the lower flange of an I-beam. The strap in which the pipe rests is made from a broad flat bar of wrought iron or steel, varying in thickness from 1/8 in., or even less for very small pipes, to 3/8 or 7/8 in. for large pipes. A turnbuckle with locknuts provides a means for adjusting the length. The rod ends in the turnbuckle are upset to give the same strength at the rest of the thread as in the full section of the rod, and the whole forms a strong, sightly hanger suitable for nearly any location where minimum cost is not considered a matter of first importance.

A large percentage of the pipes in use are suspended from overhead beams, and Figs. 4 to 12 show a variety of clamps intended for this purpose. These are mostly designed to be made of steel castings or forgings.

Fig. 10 is commonly made as shown at *A*. There is less stress upon both the pin and the clamps if made as shown in *B*. Fig. 13 represents

a hanger on T-rails used for supporting heavy pipes in a tunnel with smaller pipes hung beneath them. In Fig. 14 a pipe is supported




Courtesy *American Machinist*

FIGS. 1 TO 14. ILLUSTRATING VARIOUS TYPES OF INTERIOR PIPE HANGERS

with an adjustable hanger by grooves formed in a concrete beam. The strength of the groove was found by experiment to be far in excess of

that of the clamps, which were designed of ample proportions for the service required.

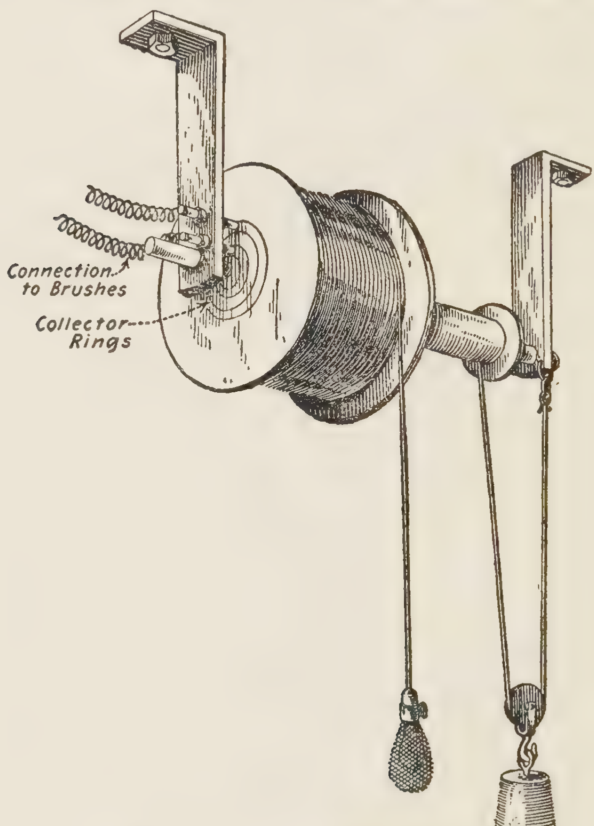
Large vertical pipes are usually supported from the bottom by means of a properly constructed special fitting provided with a base for resting upon a suitable foundation, preferably of masonry. Smaller ones may be suspended from above by rods connecting to a split collar placed beneath a convenient pair of flanges. Sometimes a vertical line is supported about midway of its length by a fitting made of a bracket form and bolted to the wall.

## *SECTION VII*

# ELECTRICAL KINKS

### ADJUSTABLE EXTENSION LAMP CORD

A METHOD of taking care of long extension cords is shown by the illustration. The reel is made up of two large disks, of galvanized iron,



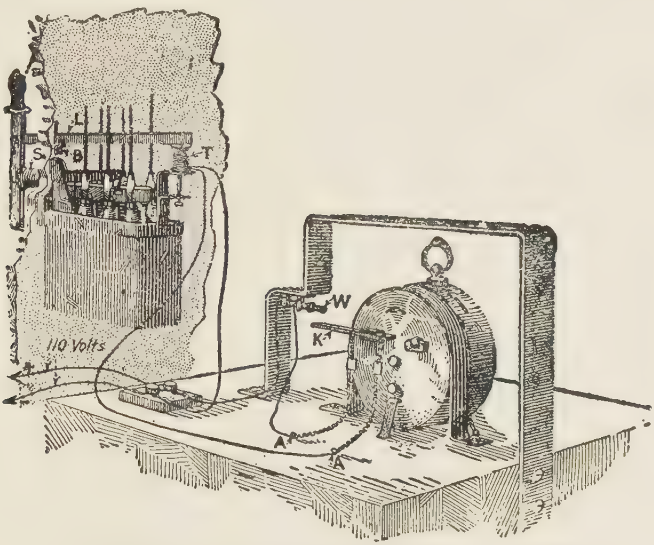

REEL FOR LONG EXTENSION CORD

separated by wooden slats to form a drum. On one side of this drum is fastened a fiber block on which were mounted two contact rings, and

current is fed to these rings through a pair of brushes fastened to and insulated from the bracket that supports that side of the reel. On the other side of the drum there is a wooden cylinder, and a shaft extends through the whole. One end of a sash cord is fastened to the wooden cylinder; the other end is passed through a weighted pulley and fastened somewhat as shown. For a 100-ft. extension we find that the main drum should be about 16 in. in diameter by about 8 in. long, and the small cylinder should be 2 in. in diameter by 6 in. long. The extension cord is wound around the main drum, and the wires at the opposite end from the lamp were connected to the contact rings. As the extension is unreeled, the rope is wound up on the small drum. When the extension is released, the weight unwinds the cord from the cylinder and the extension is wound up.

## ALARM CLOCK USED TO OPEN OIL SWITCH AUTOMATICALLY

The following describes an arrangement to turn out the street lights in a small town. The circuit was controlled by a hand-operated 2300-




CONNECTIONS OF ALARM CLOCK TO OIL SWITCH

volt oil switch, which was made automatic by the addition of an auxiliary lever, a spiral spring and by placing a steel catch block across the slot in the switchboard where the operating levels pass through, as indicated in the figure. When the switch is closed, the spring $S$ is compressed and the slot in the lever $L$ falls over the catch $B$ and holds the switch closed.

In back of the switchboard, directly under the end of lever *L* and on the frame of the oil switch, is mounted a solenoid *T*, with an iron plunger, so that when the coil is energized the iron plunger will lift the lever, thus releasing the switch.

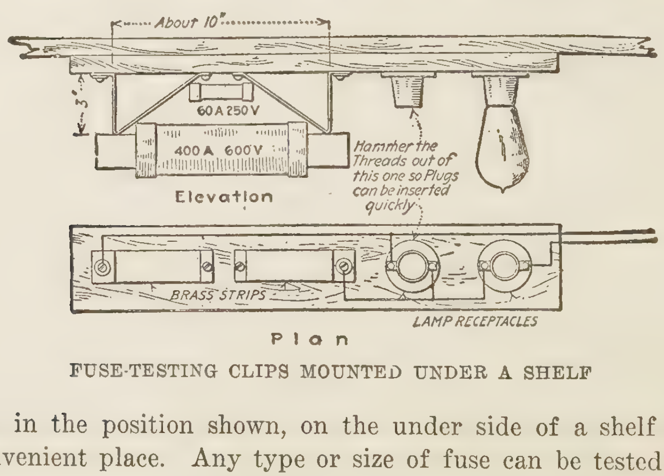
On a common alarm clock an extension was soldered on the alarm winding key, with two small holes drilled in it to attach the cords of two chains about ten inches long, as shown. In the end of each chain near the key is placed a piece of leather to insulate them from the clock. The chains and solenoid are connected in series with the 110-volt circuit. When the alarm goes off, the chains are twisted together, thus closing the circuit through the coil whose plunger trips the switch.

At first there were on the front of the board two contacts that opened, but another arrangement had to be devised, since sometimes the power was off when the time came for the clock to turn the lights out, and when the voltage was slowly built up the trip coil would not trip the switch.

This in a short time caused the coil to be burned out, and so a frame was made for the clock and a baby knife-switch mounted in back of it, as in the figure. To set the clock, which was done when the substation man came to put the lights on, it was slipped out of the frame and the alarm wound up by the key *K* and the chains hooked to contacts *A* and *A* and the switch *W* closed. When the clock goes off, it twists the chains together on the first half revolution and on the last half it opens the switch which cuts out the trip coil.

## FUSE-TESTING BOARD

The illustration shows a fuse-testing board. It is preferably



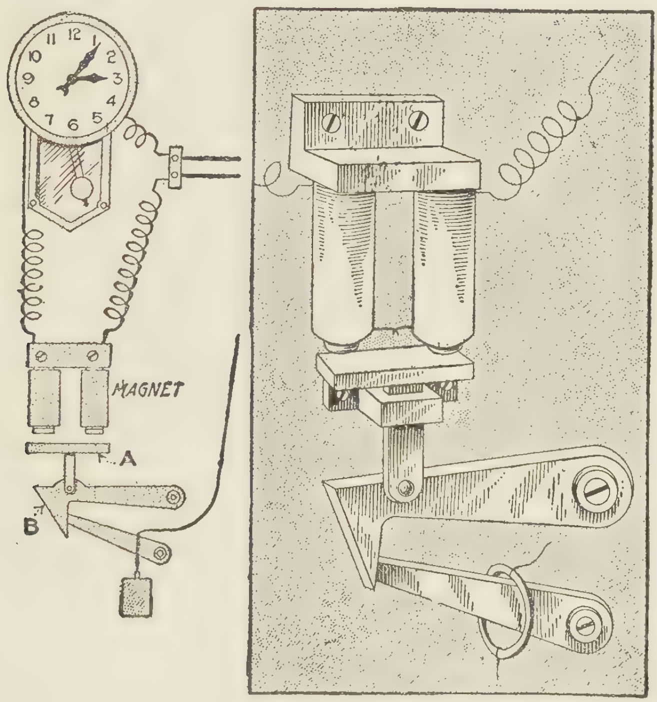

FUSE-TESTING CLIPS MOUNTED UNDER A SHELF

mounted in the position shown, on the under side of a shelf or some such convenient place. Any type or size of fuse can be tested without

making adjustments, and if located out of harm's way the current may be left on continuously.

## AUTOMATIC WHISTLE-BLOWING RIG

If the engineer is busy with other things he sometimes fails to blow the whistle at the proper time, and as in most shops the men start and stop work when the whistle is blown, it is important that it be done on




WEIGHT RELEASED BY SOLENOID ACTION

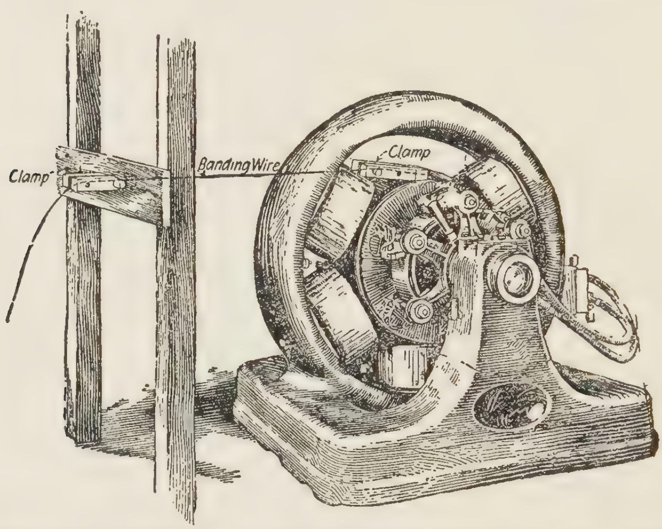
time. The illustration shows a solenoid trip for a weight on the whistle cord. At whatever time the whistle is to be blown the clock closes the circuit, actuating the magnet which lifts the plate *A* and hook *B*, releasing the weight.

The same kind of trip can also be used on a push-button alarm, engine stop or any apparatus of the kind.

## BANDING AN ARMATURE WITHOUT REMOVING IT FROM FRAME

A 50-kw. engine-driven generator began to flash at the commutator and upon shutting the machine down it was found that the middle

band on the armature had broken and parts of it came out on the commutator and brushes. It was decided to try to put on the band with the armature in place. The polepieces were bolted to the frame with bolts from the outside. This made it possible to remove the bolt from the top polepiece and take the latter out, as shown in the figure. Two wood clamps were used to hold tension on the band wire. One of these clamps was fastened to a piece of timber between two posts about 5 ft. away from the machine and the other was fastened against one polepiece inside the machine, as in the figure, and used to direct the wire on the armature. With one end of the banding wire fastened to a coil where it projected beyond the core, the armature was turned by hand



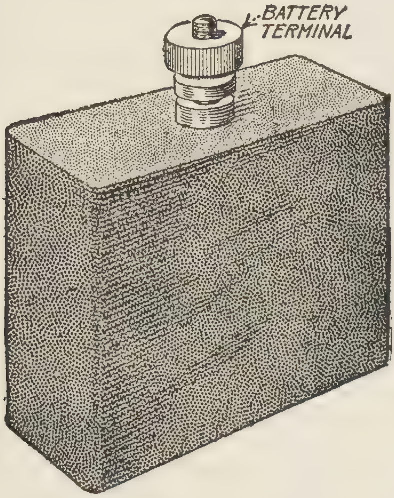

GENERAL ARRANGEMENT OF PARTS FOR PLACING BAND ON ARMATURE

and three or four turns were put on the armature, to gradually bring the banding wire over to the position of the band. The wire was then placed in the clamps and the latter adjusted to give the proper amount of tension. On the first turn of the new band the armature was worked around very carefully and the mica insulation and copper binding clips put in place; after this the remainder of the band went on easily. After soldering all around and removing the loose ends of the band, the polepiece was put back into place.

## BATTERY CARBON BRUSHES

One engineer being in need of a set of brushes for a small generator and not having a set at hand met the emergency by using the carbon

electrodes from a number of old dry-battery cells. After removing the carbons, he used the ends with the terminal connection on, cutting these to the proper dimension with a hack-saw and finishing the brushes up with sandpaper. What had been the connection to the carbon in the




BRUSH MADE FROM BATTERY CARBON

battery was made the connection for the pigtail to the brush, as shown in the figure.

## CHECKING MOTOR FIELD COILS

After trying out a 500-volt six-pole shunt-wound direct-current motor, it became evident that a compound-wound motor was needed for the work. A set of field coils was obtained from a local repair shop. The terminals of the coils were not marked and the manner of bringing out the leads was not evident. In order to avoid installing the coils to give wrong polarity, they were arranged as shown in Fig. 1, before installation, and the adjacent terminals of the shunt coils were connected as indicated. Line voltage was then applied to the series of shunt windings and a compass used for indicating their polarities. It was necessary to turn one coil end for end in order to have the polarities alternate N and S.

Leaving the coils in position, Fig. 1, the series coils were connected in series and current passed through them and their polarity tested. Of course a heavier current was required for testing the series coils, and in order to get a current that would give definite compass testing result,

it was necessary to pass through the coils the operating current of a neighboring motor by making connections as shown in Fig. 2. The result of the test was to locate a reversed series winding on one of the coils. Therefore, in installing this coil in the motor it was turned end for end, which reversed the polarity of the shunt winding of that coil, if it were to be connected up symmetrically. In order to rectify these conditions, the connections to the shunt winding of this coil were crossed, which did not make a very good-looking job, but saved considerable time in getting the machine into service. After the coils were in the motor, the tests were repeated and everything was found to be all right. As

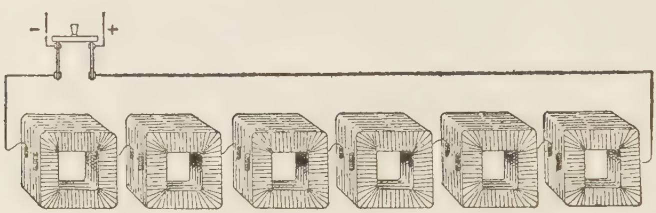



FIG. 1. CONNECTIONS FOR CHECKING SHUNT-FIELD COILS BEFORE INSTALLATION

a final check, made in order to insure that the shunt windings and the series windings would operate the armature in the same direction, the motor was started; first, by means of the shunt coils and then by means of the series coils alone. In doing this care must be exercised not to

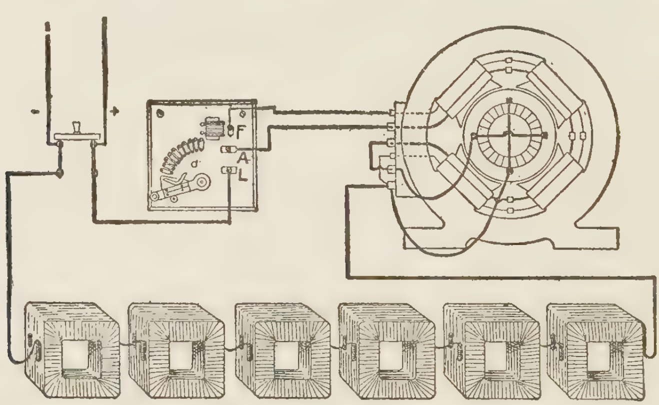


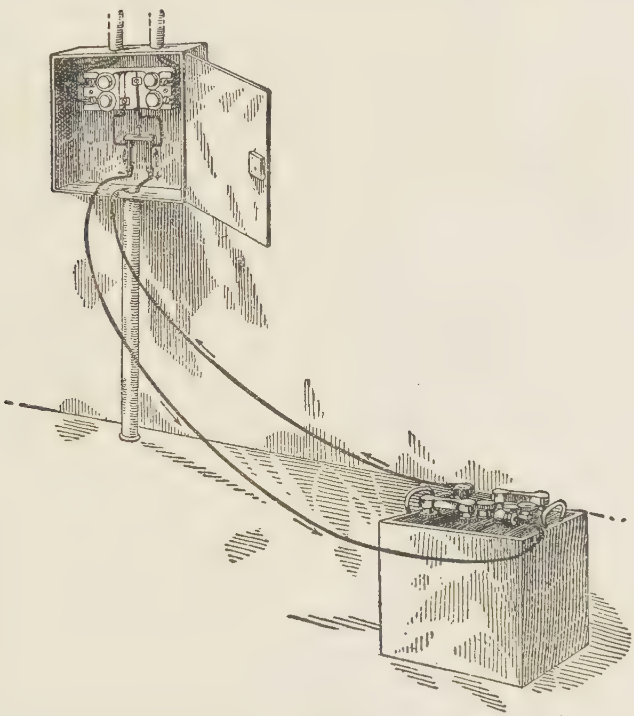

FIG. 2. CONNECTIONS FOR CHECKING SHUNT-FIELD COILS BEFORE INSTALLATION

cut the starting resistance out when the machine is operating as a series motor, or it will race and may injure the armature.

## CHARGING BATTERIES FROM LIGHTING LOAD

The problem of recharging an automobile starting and lighting battery may arise when 110-volt direct current is available. This load of about 10 amperes is a convenient resistance to connect in series with the battery to limit the charging current.

To determine the positive and negative terminals of the lighting switch, disconnect the negative wire, connecting this to the negative terminal of the battery and the positive of the battery to the switch, as indicated in the illustration. This allows charging the battery and still have enough light in the shop without making up a charging rheostat.



CONNECTIONS FOR CHARGING THE BATTERY

## COMMUTATING-POLE MOTOR TROUBLE

A new 21.5 ampere commutating-pole shunt motor was installed to drive a centrifugal water pump, but frequently, when the machine was started, the 30-ampere fuses protecting the motor were blown. Investigation showed that the motor speed was too high. The trouble was overcome by shifting the brushes forward, thus reducing the speed and current to their proper values. It is particularly important that the speed of

a centrifugal pump be correct, as the power required to drive it varies with the cube of the speed. It is also important that the brushes of a commutating-pole motor be properly set. A greater effect is produced in a commutating-pole motor than in a noncommutating pole by incor-

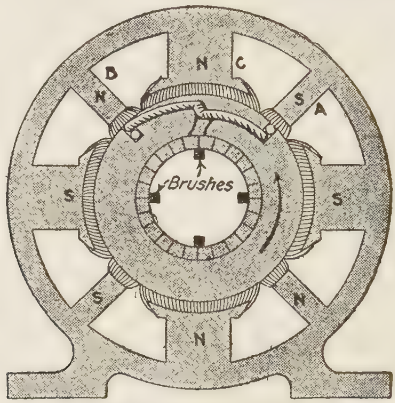



FIG. 1. INTERPOLE MOTOR WITH BRUSHES LOCATED IN CORRECT POSITION

rect brush setting. The theory of this change of speed in an interpole motor is as follows:

When the brushes are in the correct position, as shown in Fig. 1, the coils on the armature between commutating poles $A$ and $B$ are cutting flux from the main pole $C$. If they cut any of the flux from

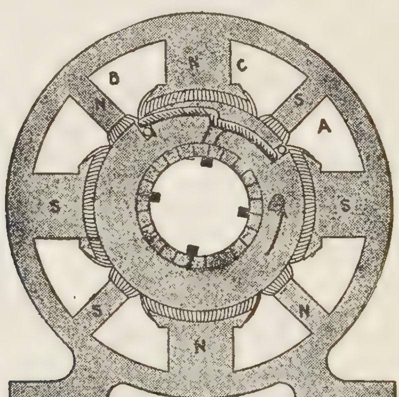


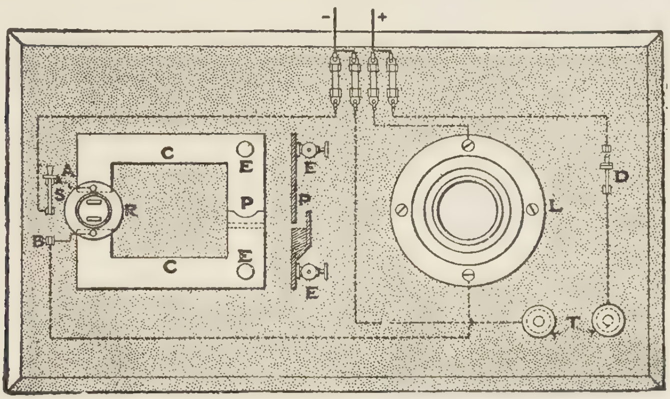

FIG. 2. INTERPOLE MOTOR WITH BRUSHES LOCATED OFF CORRECT POSITION

the commutating pole $N$, they also cut an equal number of lines of force from the $S$ commutating pole, hence the voltage in these coils is not influenced by the commutating flux. But if the brushes are shifted backward to a position as in Fig. 2, the coils between the sides of the coil under commutation will be cutting the flux of the main $N$ pole $C$

and also from the flux from the *S* commutating pole *A*, thus decreasing the effective volts generated in these coils and causing the speed to increase. If the brushes had been shifted forward, the speed would have been decreased.

## A CONVENIENT ARRANGEMENT OF PLUG-FUSE TEST BOARD

The figure indicates the construction of a plug-fuse test board. Plug fuses are tested by placing them at *P* and closing switch *S* to *A*, and cartridge fuses are tested by placing them so that their ferrules rest on the brass strip *C*. These strips are connected to the terminals of a receptacle *R* from which an extension cord may be taken for testing




ARRANGEMENT OF DEVICES ON TEST

equipment on the bench or shop floor. The receptacle may be replaced by binding posts *E*, as shown. Terminals *T* are for supplying power, by closing switch *D*, to any small equipment that comes within the capacity of the fuses mounted on the board. By closing the switch *S* to *B* the lamp *L* will burn continuously and may be used for lighting around the bench.

## DEVICES FOR CARE OF BRUSHES AND COMMUTATORS

Possibly one of the most disagreeable tasks that confront those who have the care of electrical machinery is that of sandpapering brushes to a surface fit on the commutator. To facilitate this work make a holder for the brushes as in Fig. 1. This device is preferably iron, but if made of wood the templet edge can be of metal and attached to the holder.

The brushes are put in the holder and held rigidly by means of the screw *A*. A fine-toothed hacksaw is then drawn along the templet edge,

cutting the brushes to shape. A smooth surface can be obtained by means of a piece of sandpaper laid over a file or block of wood, using

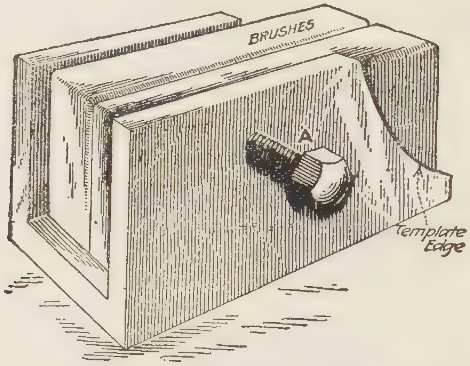



FIG. 1. TEMPLET FOR CUTTING BRUSHES TO SHAPE

the templet as a guide. The templet can be cut to the proper form by using an old brush as a guide, and when in use held in a vise.

When the brushes are put in the holders on the machine, it will be

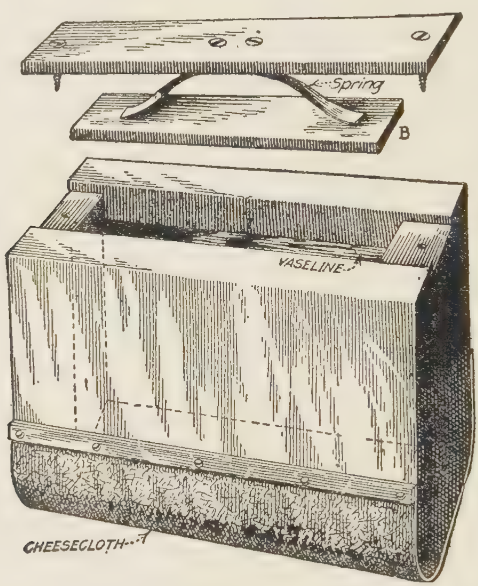



FIG. 2. COMMUTATOR LUBRICATOR

found that the major portion of the work has been done and to secure a good fit with the commutator only a few strokes of the sandpaper will be necessary.

Proper lubrication of the commutator will do much to avoid the many troubles that arise from the wearing and cutting of the commutator and brushes. The practice of using a piece of oily waste as a lubricator often accentuates the trouble. Vaseline sparingly used furnishes ideal lubrication for commutators. Fig. 2 shows the device employed for applying the vaseline. It consists of a block of wood with a slot cut through it as indicated. One end of the slot is covered with cloth, preferably cheesecloth, arranged in a number of layers, so that each layer can be readily removed when necessary. The slot is filled with vaseline, which is pressed against the cloth by means of a spring cover arranged as shown at *B*. The heat of the commutator and the pressure of the spring will cause a sufficient amount of the vaseline to exude through the pores of the cloth to furnish the necessary lubrication.

## DISMANTLING A LARGE MOTOR

A three-bearing equipment, the motor's rotor and generator's armatures was keyed on the same shaft. The middle-bearing housing

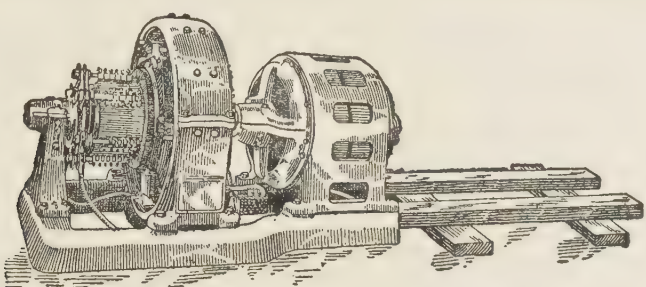


FIG. 1

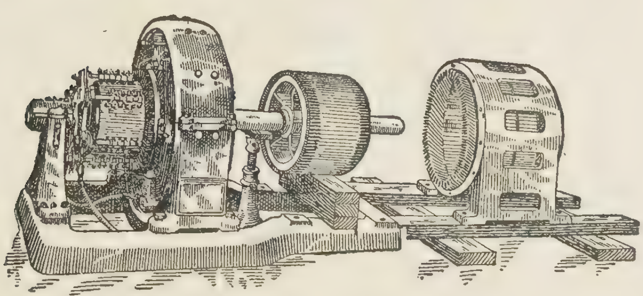


FIG. 2

FIGS. 1 AND 2. MOTOR ASSEMBLED AND STATOR REMOVED FROM BASE

was mounted on the motor and was split horizontally as in Fig. 1. In taking the machine apart to get at the stator winding in the motor, the

inner bearing was removed, the base bolts and dowels taken out and the stator pushed out so that the end of the rotor shaft was only one-quarter way in the outer bearing, then a jack was set under the shaft as close as possible to the rotor and the weight of the latter taken on it, a wooden block being placed between the jack and the shaft to prevent injury to the latter. Then an extension to the bedplate was built with timbers, and after this the outer bearing was removed and the stator pushed out on the beams so that the winding could be repaired.

The bottom coils had become soaked with oil, rotting the insulation, and no doubt the vibration of the coils themselves did the rest. The tools used to lift the coils were like those shown in Fig. 3. No. 2 was

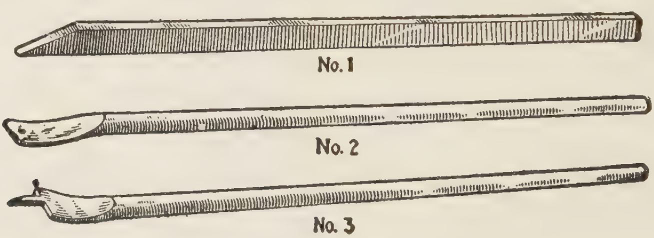



FIG. 3. TOOLS FOR REMOVING COILS

used to raise the coils a little at one end, then No. 1; the wedge-shaped one was pushed under the coils in the slots and used to pry them up. No. 3 has projecting shoulders which rest on top of the slot and is used as a powerful lever for lifting tight coils. They are all made of steel in sizes to suit small or large machines. The edges, of course, are nicely rounded in order to prevent damage to the coils. When the machine was again ready for service it was easily assembled by reversing the dismantling operations.

## DRYING OUT A GENERATOR

The apparatus, in a basement, had been under water for several days. There was no outside source of power for drying out the generator electrically, owing to the fact that the city light plant had also been flooded. The customer's boiler room was on the same level as the power plant, therefore it was impossible to raise steam to run the engine and dry out the generator by the short-circuit method. It then became necessary to devise original means whereby the necessary heat could be produced and properly applied. It was decided to build a corrugated sheet-iron house around the engine and generator, and place two wood-burning stoves inside, with openings made in the walls of the house for supplying fuel to the stoves. This was feasible, inasmuch

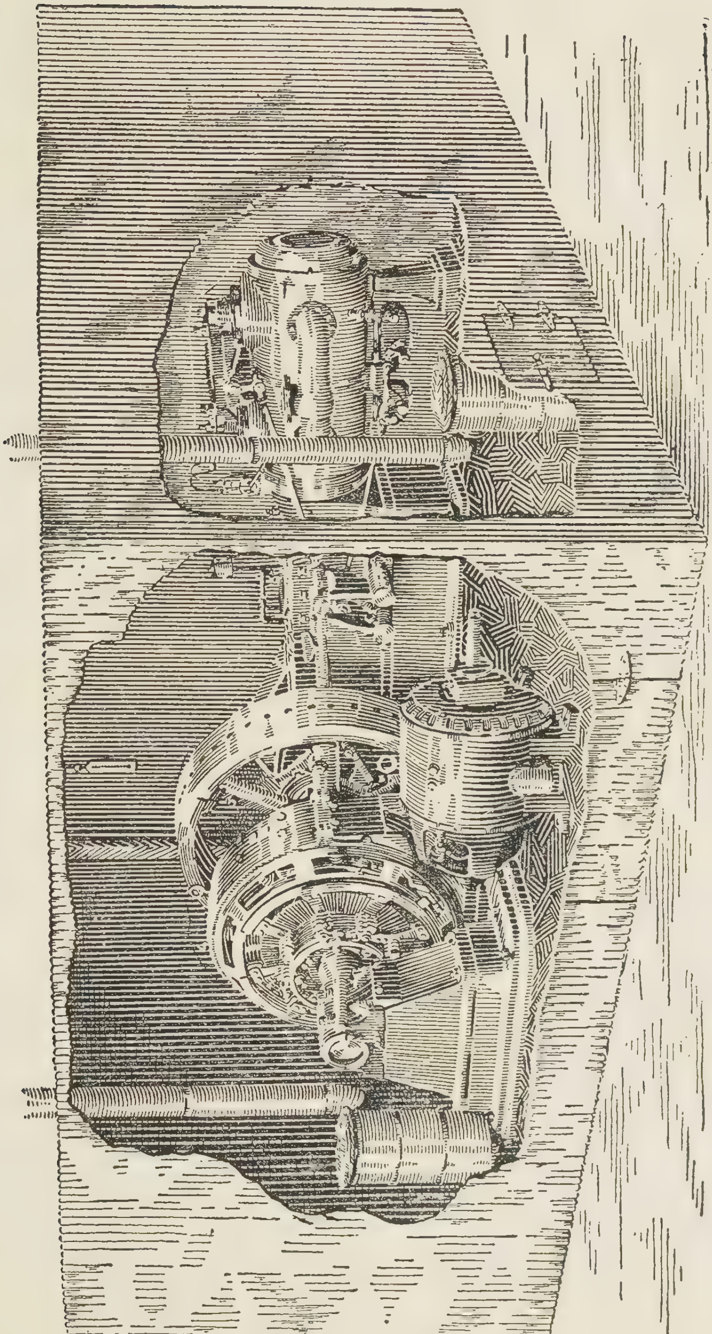


FIG. 1. IRON BOX AND ARRANGEMENT OF EQUIPMENT INSIDE FOR DRYING

as the floor of the engine room was concrete. Fig. 1 shows the general plan of the layout. The openings formed by the corrugations were sufficient to allow the moisture to escape from the box.

After completing the house and drilling holes in the top for the insertion of thermometers, fires were built and the temperature inside raised to about 90 deg. C. Arrangements were made for a night fireman, who was required to record the temperature readings every half hour, to avoid overheating and damage to the apparatus. Practically constant temperature was maintained in this housing for about five days and nights. At the end of this time the generator was fairly dry excepting for some excessive dampness inside the commutator.

Since the commutator moisture was inside the V-rings, external heat did not seem to have much effect on eliminating it, and heating the commutator itself was decided upon. This was done by running the generator with the shunt field disconnected and the armature short-circuited through the series winding, causing a heavy current to flow and generating a large amount of heat at the commutator. The voltage under these conditions was very low, consequently there was no danger of the machine breaking down to ground. However, in order to avoid generating sufficient current to damage the armature coils, a portable ammeter was placed in the circuit, as in Fig. 2, and the current kept at a safe value by throttling the engine. Blow-torches were applied to the commutator, and after short-circuit operation for about a day and a half, the machine was considered to be in serviceable condition.

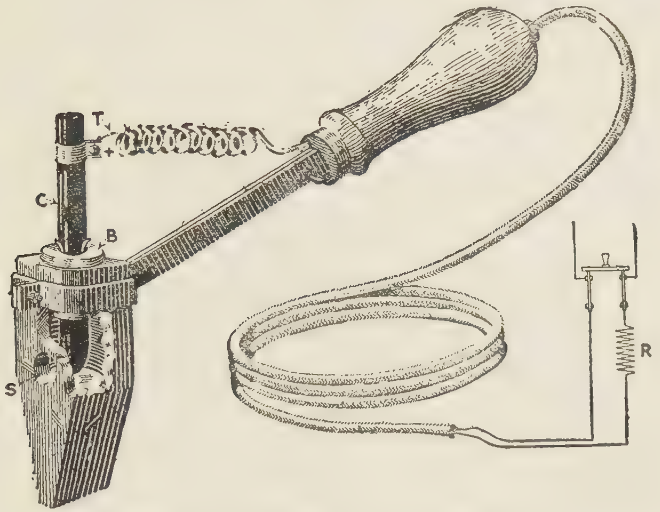
## AN ELECTRIC-ARC SOLDERING IRON

Most electric soldering irons are constructed so that they are heated by the current passing through a resistance coil inclosed in a tube attached to the top of the iron.

The illustration shows an electric soldering iron that is heated by an electric arc in the iron itself. A hole is bored in the center of the iron, having a diameter equal to the outside diameter of the tube of a battery bushing, down to where the iron begins to taper. A standard battery porcelain bushing *B* is placed in the hole and a ⅜-in. arc-lamp carbon *C* is placed in the bushing, and allowed to come down in contact with the bottom of the hole, then the carbon is withdrawn about ¼ in. to establish the arc. The iron should be connected to a 110-volt circuit and resistance enough connected in series to keep the current down to between two and three amperes. About 30 ohms will be sufficient. This resistance may be made of about 600 ft. of No. 18 B. & S. iron wire and connected in the circuit, as at *R* in the figure.

The soldering iron is connected to the circuit with the positive terminal on the carbon, as shown at *I*.

The carbon is held in place in the bushing by small metal wedges, and adjustment of the carbon is made by tapping it down to give the desired length of arc. A second hole *S* is bored at right angles to the




ASSEMBLY OF ELECTRIC-ARC SOLDERING IRON

first, so as to allow the arc to be cleaned of the nitrate that forms around it.

## EMERGENCY AUTOMATIC CONTROLLER

When an automatic controller on a pump or air-compressor motor must be taken out of service for repairs, a temporary controller can be made from an ordinary starting box having four binding posts. In this type of starter the no-voltage release coil is connected across the line and not in series with the shunt-field windings as in the three-terminal type. In Fig. 1 is shown a type of automatic starter in common use for automatically stopping and starting pump and air-compressor motors. The figure gives the connection for controlling a pump motor through a float switch operated from a float in the tank. When the float switch closes, the solenoid coil on the controller is energized, which in turn closes the contact and brings the motor up to speed automatically. When the tank is full the switch opens, de-energizes the coil, and allows the contractors to open and shut down the motor.

In Fig. 2 the controller of Fig. 1 has been replaced by an ordinary starting box with four terminals. With this arrangement the motor will not start up automatically when the float switch closes, but will be shut down automatically when the float switch opens. If the water in the tank is at a level where the float switch is closed, when an attempt is made to start the motor, the starting arm will be held in the full-on position by the no-voltage release coil. When the tank has been filled

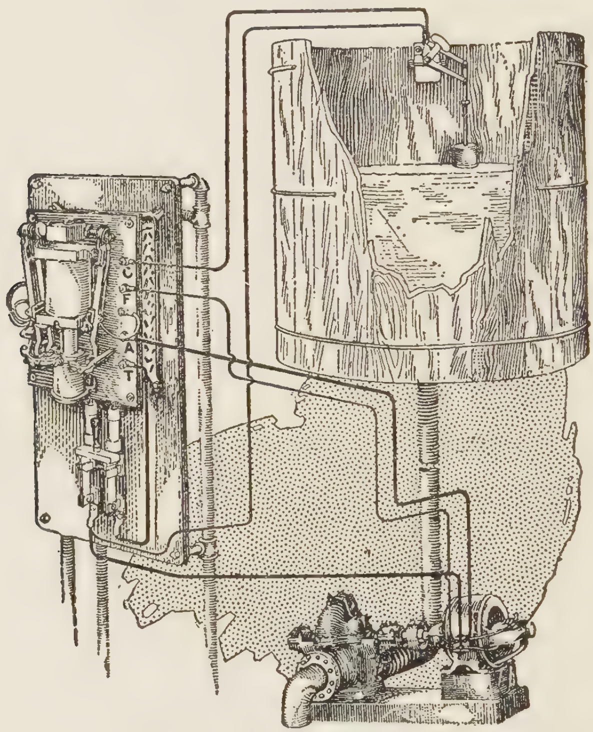


FIG. 1. CONNECTIONS FOR CONTROLLING PUMP MOTOR AUTOMATICALLY

and the float switch opens the no-voltage release-coil circuit, the starter arm will be released and the motor shut down automatically. However, if when the attendant started the motor, the water in the tank was at a level where the float switch was open, then the no-voltage release coil would not hold the starter arm, thus indicating to the attendant that the tank was still full. This device although not starting the motor automatically, does stop it automatically and also gives the attendant an indication of the height of the water in the tank when he goes to start

the motor. This is generally all that is requires of a temporary controller on a pump or air compressor.

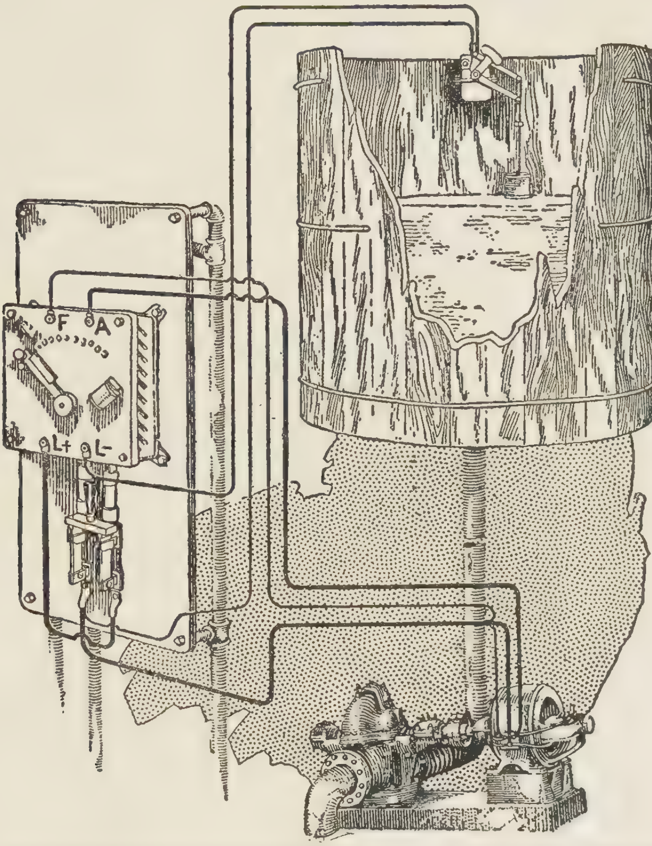


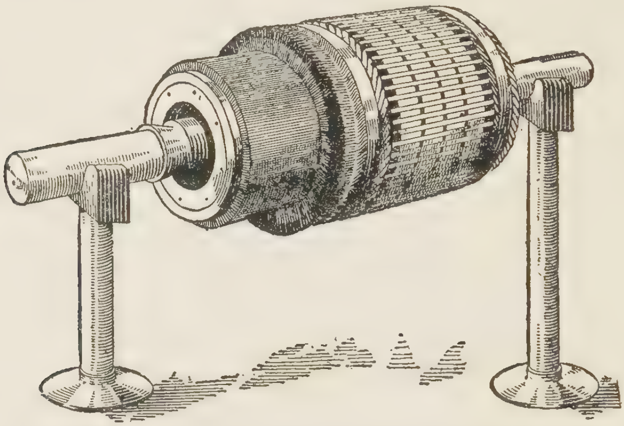

FIG. 2. CONNECTIONS FOR CONTROLLING PUMP MOTOR WITH STARTING BOX

## FAULTY SOLDERING CAUSED TROUBLE ON DIRECT-CURRENT ARMATURE

When soldering the armature connection of direct-current machines to the commutator risers, it is advisable to tilt the armature slightly, as shown in the illustration, so that the solder will have a tendency to run toward the front of the risers. If this precaution is not taken, trouble is likely to occur due to loose pieces of solder lodging behind the commutator lugs. The armature may test all right and be put into service without the trouble showing up for a considerable time, but eventually it will do so, as the following example will illustrate:

This particular machine had given no trouble for two years or more. Then the commutator began to get excessiveely hot in places, due ap-

parently to carbonized mica, as the bars were badly discolored by the heat. It was decided to re-mica the bad sections of the commutator. In carrying out this operation it was unnecessary to disturb the connections, as with the commutator loosened up it was a simple matter to slip the new mica between the segments. After tightening up, a bar-to-bar test was made with a millivoltmeter and everything appeared to be all right. The commutator was then trued up in the lathe, the surface shorts picked out and tested once more. The result this time was far from satisfactory. Four low readings were found between segments, indicating shorts, but not in the same position as the faults had been previously. This was rather unusual, and the only thing to do



ARMATURE ON PEDESTALS WITH COMMUTATOR END LOWER THAN PULLEY END

was to open up the commutator again and put in more mica. After this was done a test was made which showed that one short had gone, but two more showed up. When the operation of loosening and tightening the commutator had been completed about six times with the trouble coming and going, it was decided to lift the leads out where the bad spots were. When this was done, the source of all the trouble was uncovered. Pieces of solder were found packed in between the risers and the tape used as a space filler at the back of the commutator. All the leads were then lifted, the tape taken off and the excess solder removed.

After soldering up again, the armature tested all right, no further trouble occurring. It was apparent that in loosening the commutator to insert the new mica, the solder had been disturbed, allowing it to come in contact with the segments. The fact that the armature had been well varnished and baked probably prevented the trouble from taking place during the time the machine was in use.

## GENERATORS WOULD NOT OPERATE IN PARALLEL

A compound-wound generator would not operate in parallel with the other machine in the plant. An investigation indicated the condition shown in Fig. 1.

The equalizer connection on machine No. 2 is connected between the armature and the positive bus. Furthermore, closing the equalizer switch

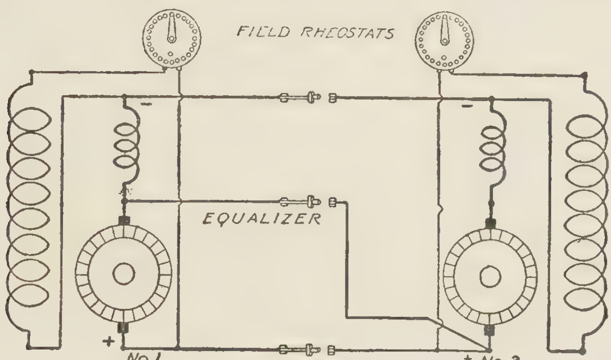



FIG. 1

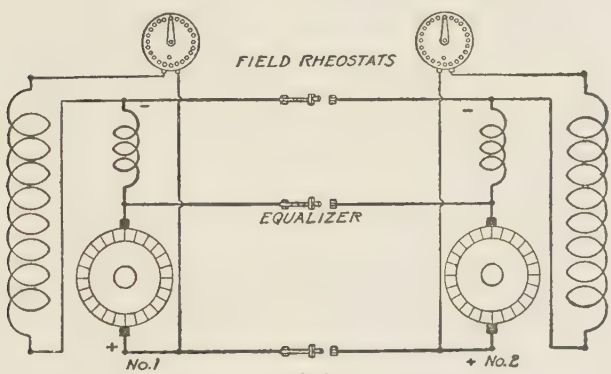



FIG. 2

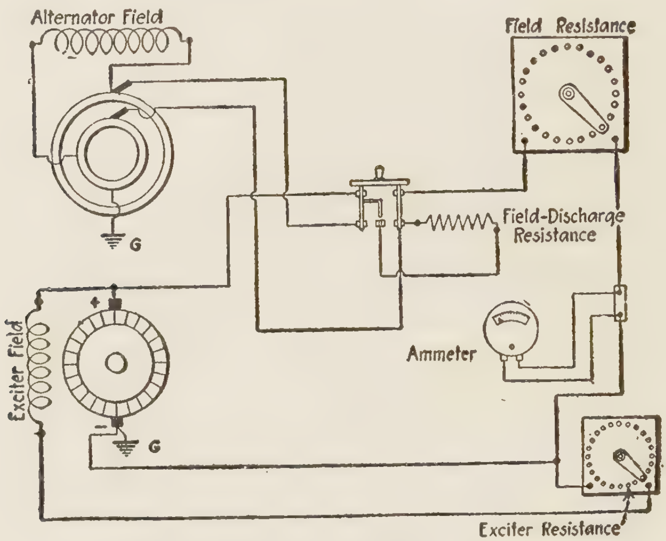
FIGS. 1 AND 2. SHOWS WRONG AND CORRECT CONNECTION OF EQUALIZER

short-circuits the armature of machine No. 1 and connects machine No. 2 across the series field of machine No. 1. Fortunately, the machines were belt-driven or the damage done might have been more serious than badly burned commutators and brushes, before the circuit-breakers opened and cleared the trouble. On making the equalizer connection between the armature and series field on machine No. 2 and determining that the polarity of the two machines was correct, they were paralleled without any further trouble.

It is evident from the figures that a wrong equalizer connection between two compound-wound generators may cause just as serious a condition as attempting to parallel two machines having opposite polarity.

## GROUNDS CAUSE ALTERNATOR TO LOSE FIELD CONTROL

A suitable resistance was installed in the field circuit of a 120-kva. three-phase 60-cycle 600-volt alternator, with direct connected exciter, to operate in parallel with other units. When testing the unit the




WIRING DIAGRAM OF EXCITER CIRCUITS

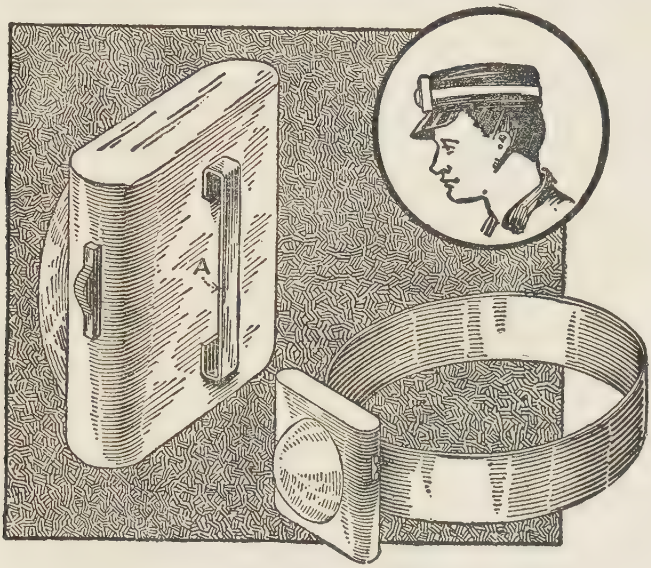
regulation was satisfactory until about half the resistance was cut out, when the voltage jumped to its full value and the field ammeter failed to give a reading. The resistance box was tested and found to be in good condition, then all wiring was checked. The trouble was finally located in one brush-holder on the exciter and one collector ring on the alternator being grounded as in the diagram. After these repairs were made, the control was satisfactory again.

## HEAD-BAND FOR BATTERY LIGHT

It is sometimes inconvenient to hold an extension lamp or the work may require two hands. A lamp for use in dark corners which is mighty handy can be made as follows. Take a small flashlight, with the light in the side and solder a small strip of brass on the back as shown at *A* and, through it put a wide elastic head band. In places where it

is unhandy to hold a lamp, or where the space is too small for two to stand, this little headlight will be found handy.

Another convenient tool around a plant is a small mirror on a handle, to be used in the same way as a dentist uses his glass in the mouth to see some cavity he cannot see readily from the outside.




SMALL BATTERY LAMP HELD BY AN ELASTIC BAND

## HOW TO DO A GOOD JOB CUTTING CONDUIT

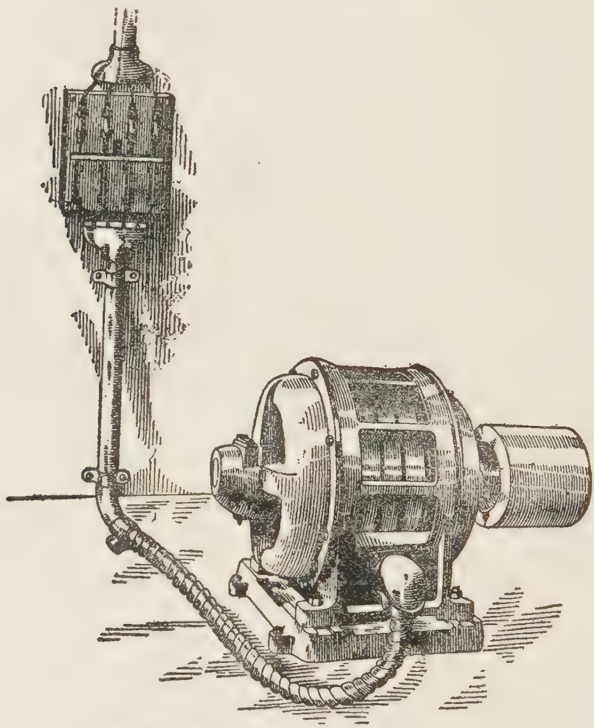
It is well known that conduit must not be cut with pipe cutters because of the sharp edge or burr that is left on the inside. Unless this burr is filed or reamed out, it will damage the insulation of the wires when they are pulled through the conduit. For this reason a hack-saw is used on most conduit jobs. However, the method is slow and it is also difficult to make a straight cut on the larger sizes of conduit.

A method that has been found satisfactory is to use the pipe cutters first, cutting as deep as possible without causing the burr, then finishing with a hacksaw, which will not take long and will assure a straight cut.

It is surprising how this speeds up a conduit job. The value of this method increases with the size of the conduit.

## INDUCTION MOTOR FAILED TO START

A two-phase four-wire four-pole 500-volt induction motor failed to start when the switch was closed. No starting device was used, the stator winding being connected directly to the line through the four-pole single-throw fused switch, as shown in the illustration. Upon closing this switch the motor made a noise similar to that of an induction



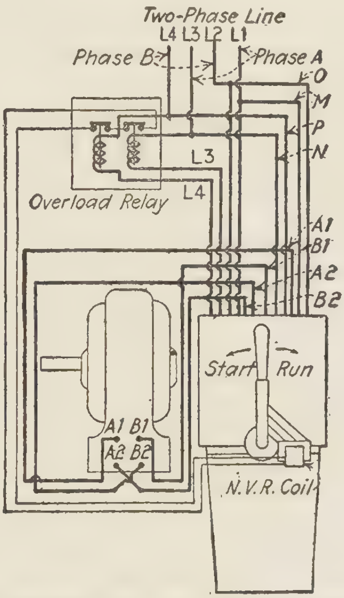
ARRANGEMENT OF MOTOR INSTALLATION

motor with one phase open. The fuses were removed and tested and were found in good condition. The stator winding was also tested, but no trace of a ground or an open-circuit was found. The trouble was caused by an attendant who had opened the fuse clips a small amount so that he could remove the fuses easily. Upon replacing the fuses it was found that one of them was held tightly by the bottom clips, but a very small air space remained between the upper ferrule and the top clips. Thus, when the switch was closed the motor was placed across the line with one phase disconnected. Upon tightening the clips, the motor was started without further trouble.

## REMEDIED INDUCTION-MOTOR TROUBLE

The motors were 440-volt two-phase 60-cycle squirrel-cage machines directly connected on a common bed-plate to 250-volt direct-current generators of the interpole type. The usual auto-starter, with overload relay and no-voltage release, was supplied for starting.

It was discovered that the man who wired up the motor had connected one of the *A* phase leads from the auto-starter to a *B* phase terminal on the motor, and vice versa, as shown in the figure. The two-phase motor had two separate non-interconnected windings and it was there-




WIRING DIAGRAM OF COMPENSATOR AND TWO-PHASE MOTOR, "A2" AND "B2" LEADS CROSSED

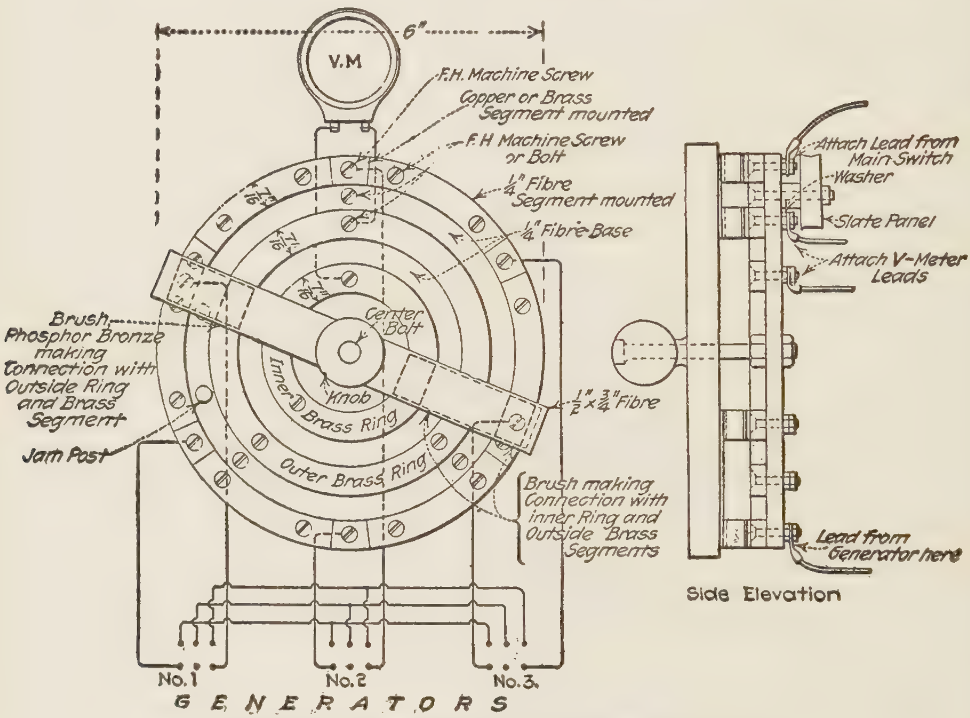
fore impossible to get any response from the motor connected as in the diagram. As is obvious from the figure, all that was necessary to correct this trouble was to interchange the leads connected to the terminals *A2* and *B2* on the motor. After doing so the motor was found to start up and carry its load in an entirely satisfactory manner.

## AN INEXPENSIVE VOLTMETER SWITCH

The voltmeter switch shown was designed for use with three generators working in parallel. This switch overcomes some of the objections found in so many types of switches, such as the following: The

liability to injury from careless handling; liability to loosen and turn around; liability of contacts to get out of line and sieze; liability to spread a film of dust or metal from segment to segment and cause a short-circuit; liability to collect dust in pockets and destroy electrical connection in places; electrician's weakness.

In using this voltmeter switch there is no cause for anxiety about the calibration of the meter when two or three machines are thrown together for the same meter will be used for both and all machines.




PLAN AND SIDE ELEVATION OF VOLTMETER SWITCH

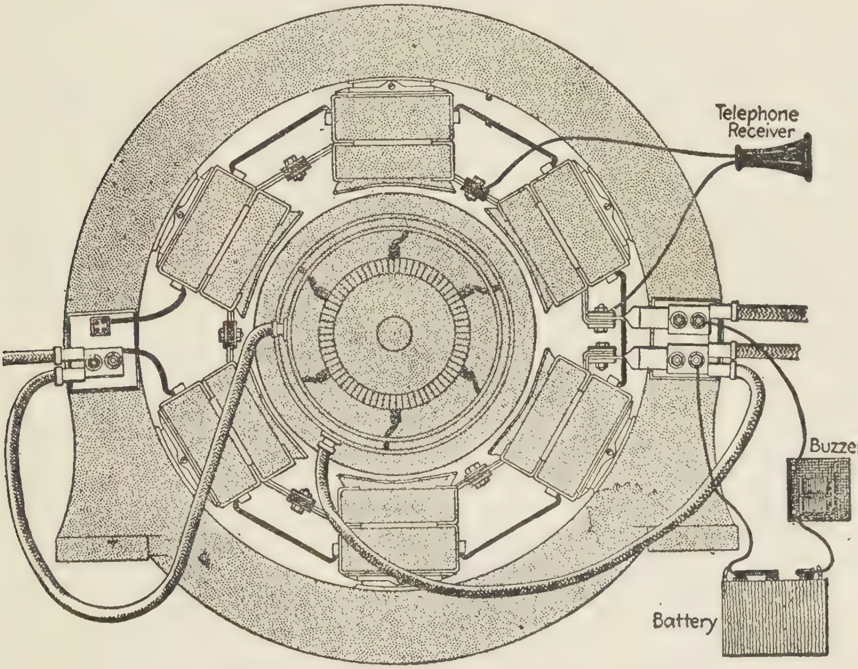
It is inexpensive to make, as the only machine parts are the two brass rings and the round fiber base on which the segments and rings are mounted. The plan view shows the connections for three generators. The three short segments can be marked Nos. 1, 2 and 3 generator respectively so as not to cause any confusion in reading. The two brushes are always in contact with the rings, and it is impossible for arc to carry from one short segment to another on account of their distance apart.

## LAMP KEPT THE METER WARM

After having considerable trouble in getting a clock in a graphic meter to run, and noticing that it ran better on warm days than on cooler ones, a small carbon-filament lamp was placed in the meter and connected to a 110-volt circuit. After the lamp had raised the temperature in the meter case, the clock ran all right. It was decided that the oil became thick when cold and retarded the action of the clock movement. When the lamp warmed the inside of the meter, the oil thinned and the clock ran as it was intended.

## LOCATING DEFECTIVE FIELD COILS

There are several ways of using a telephone receiver instead of a millivoltmeter to detect and locate faults other than those in an




CONNECTIONS FOR TESTING SERIES-FIELD COILS

armature. As an example, some time ago, in an isolated plant, a 150-kw. 550-volt six-pole direct-current generator failed to maintain its voltage on full load. The speed, shunt excitation, etc., were the same as before the trouble. It was decided the difficulty was in the compound winding or probably part of a shunt-field short-circuited.

A set of batteries and a buzzer were obtained and a telephone receiver was taken off a near-by telephone. The buzzer and batteries were connected in series with the compound winding, and each series coil was bridged with the receiver, as in the figure. One failed to make the receiver vibrate, indicating that the coil was short-circuited. The shunt-field coils were also tested in the same manner, and it was found that a defective shunt-coil has short-circuited part of the series coil that was on the same polepiece.

## LOOSE BOLTS CAUSED INDUCTION MOTOR TO HUM

A 440-volt three-phase induction motor driving an air compressor gave trouble due to blowing its fuses. The line to the motor ran through conduit and was tested and found to be free from grounds. Next, the winding was inspected, the insulation found to be in poor condition, and it was decided to have the motor rewound. A potential of 600 volts was applied between the winding and frame, which punctured the insulation in a number of places. After the motor was wound and placed in service again, it ran for about a week, when it developed a loud hum. It was taken apart again, and it was found that the end shield bolts on both ends were not as tight as they should have been, but no attention was paid to this until the winding was inspected and found to be in first-class condition. Assembling the motor and tightening the end shields proved that the hum was due to the loose bolts.

## LOOSE CONNECTION CAUSES MOTOR TROUBLES

A 10-hp. 500-volt direct-current motor was giving trouble owing to the fuses blowing. A circuit-breaker was installed in place of the fuses, but the shop was still frequently shut down. The motor and the starting box were taken to a shop and were given what was supposed to be a complete overhauling. When they were reinstalled and tested, the armature started very slowly and the starting-box resistance became very hot, which indicated that the field circuit was apparently open. The starter was opened up and the field circuit was found to be connected as shown at *B*, in Fig. 1. Since practically all the line voltage is absorbed in the starting resistance when the starting-box handle is on the first contact points, the voltage across the field coils is very low, hence the field current is very small. This caused the armature to develop practically no torque or pulling power, which accounted for its slow speed and the heating of the starting resistance.

By changing the field connection inside of the starting box to that at *B*, Fig. 2, the starter trouble was relieved and the motor was again

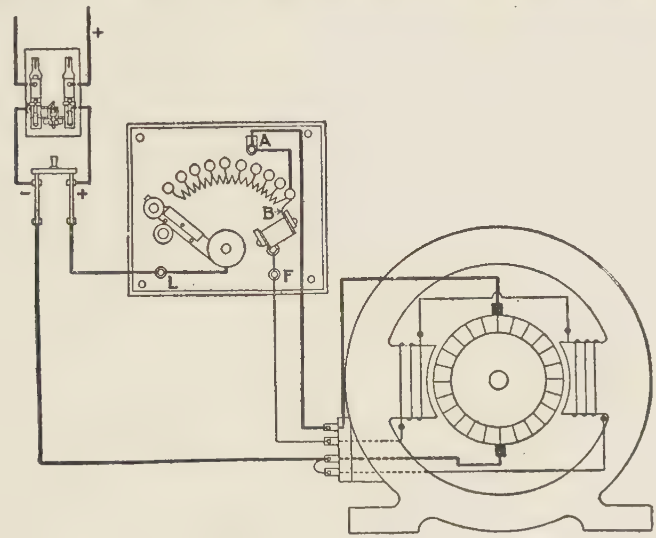



FIG. 1. SHOWS WRONG CONNECTION IN STARTING BOX

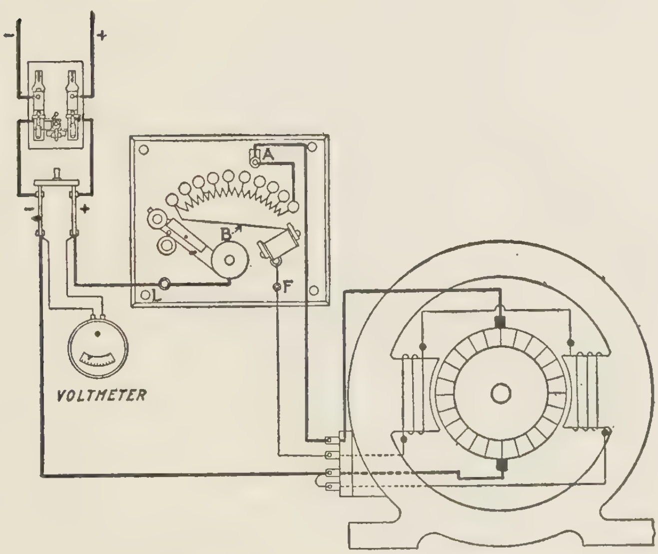


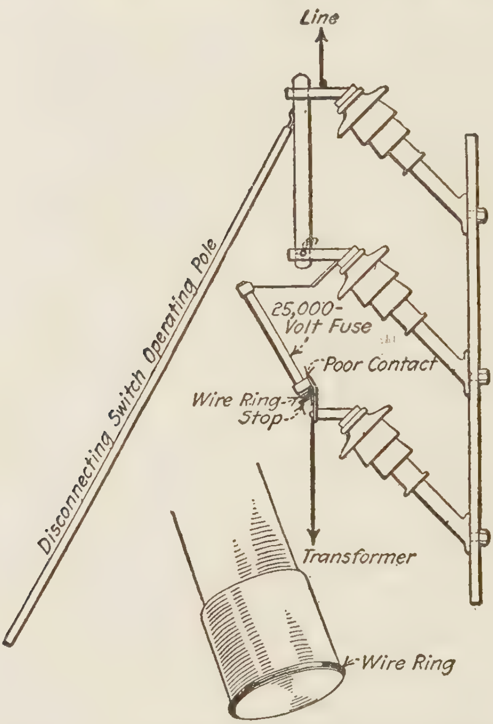

FIG. 2. STARTING BOX CORRECTLY CONNECTED

put into service. In a short time the circuit-breaker opened again and caused the plant to be shut down. This showed that the trouble had not been corrected. A study of the conditions indicated that the motor

showed no bad effects and the breaker did not open from a short-circuit, but that the trouble was apparently caused by a loose connection, which opened the line for a few seconds and closed it again before the starting-box handle returned to the off position.

A voltmeter was connected across the switch as in Fig. 2, and watched for a drop in voltage before the breaker opened. If the voltmeter had showed a drop, the trouble would have been between the switch and source of power. But the voltage was steady, hence the trouble was between the switch and the motor. Starting at the switch all connections were examined. The armature leads were held in brass terminals by setscrews. One of these screws had worked loose, thus permitting the circuit to open momentarily at this point due to vibration. The joint was covered with tape, which held the lead in place and also made the trouble difficult to locate.

## LOOSE FUSE CAUSED VOLTAGE TO BE UNBALANCED




COMBINED HIGH-TENSION SWITCH AND FUSE

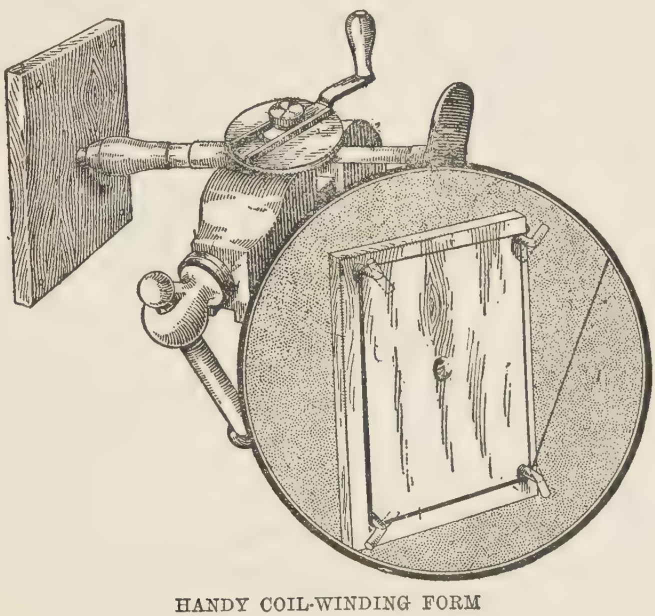
A 200-hp. 2300-volt three-phase motor upon comparing phases showed that the current per phase was 39, 44 and 30 amperes respectively, with voltmeters indicating 2400, 2450 and 2400 volts.

With the motor shut down the voltmeter showed all phases equal. The trouble was found with fuses. The combined disconnect switches and fuse blocks were mounted upright, and a 20-ft. stick was used to open and close the switches. The sudden shock of closing had worked one fuse up until it was making a poor contact between the clip and the fuse ferrule. As the full-load current at 25,000 volts was only about five amperes, there was no excessive heating at the fuse or clip.

To prevent a repetition of the trouble a small brass wire ring was soldered to the extreme lower end of the fuse ferrule. The ring was placed so as to slide between switches and fuses. In the last-named the trouble was found. Our combined disconnect switches and fuse blocks were the fuse clip and the lower stop, as in the figure.

## MAKING COILS FOR SMALL WINDINGS

The illustration shows an easy way to make coils. The rig consists of a flat piece of wood about ¾ in. thick on which is plotted out the shape of coil, with right-angle screw-hooks at all angle points, pointing away from the center of the form.



HANDY COIL-WINDING FORM

Mark out the center and then run a screw through as far as it will go and clamp it in a breast drill, as shown. Put the breast drill in a vise in a horizontal position with the coil form toward the left, taking

care to place it so as to allow free movement of the handle. Take a turn with the wire on a nail on the back of coil form, lead the wire over the edge to the face of the form and turn the handle to cause the form to revolve at any desired rate of speed and the wire to run over all screw-hooks. Keep sufficient tension on the wire to permit the turns to lie snugly. When the specified number of turns has been wound, twist a short piece of wire around each end of the coil to hold it in shape. To remove the coil, turn all screw-hooks, as shown by the dotted lines, toward the center of the form and slip the coil off.

## METHODS OF TESTING POLARITIES OF CIRCUITS

It is sometimes required to determine the polarity of a circuit when no voltmeter is available, in which case one of the following methods will serve.

Take a glass of salt water and after connecting a lamp or two in circuit for resistance place the two wires in it with a piece of clean lead attached to each. After a short period the positive will turn a reddish brown, and the negative will turn grayish.

A small pocket compass may also be used as a polarity tester. Lay the wire so that it points north and south and place the compass over it. The needle will be deflected eastward if the current is flowing north and to the westward if the current is flowing south.

An ammeter may be used to test for direction of current if there is a plus sign on the instrument to indicate the polarity.

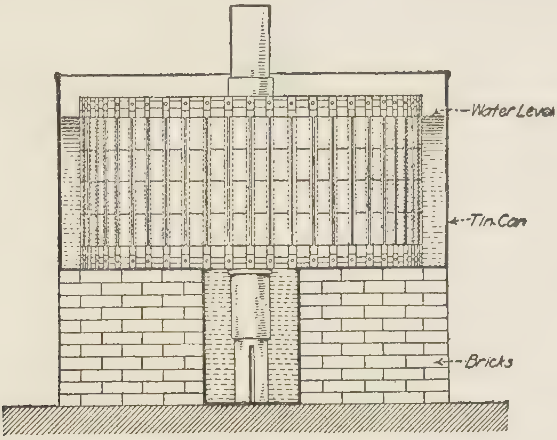
There are many other ways of testing polarity, such as the observation of two arc-lamp carbons immediately after turning off the current. The positive will be the hottest one and therefore the brightest. Or if a paper is moistened with iodide of potassium and touched with the two terminals, the positive one will leave a brown mark. All these tests, however, involve the use of some device or apparatus, and it often happens, as in the field, that none of these means is available. The simplest test possible is to stick the ends of the wires into some moist substance, preferably a potato, apple or onion in the order named. Boiling or bubbling will occur at the negative terminal.

It is sometimes necessary to distinguish between an alternating- and direct-current circuit. In this event none of the tests mentioned can be used, for the action would be similar at both terminals. There is, however, an easily distinguishable difference between the arcs produced by the two. Upon breaking or interrupting an alternating-current circuit the arc will only sputter and is easily extinguishable; while with a direct-current circuit under the same conditions the arc will have a tendency

to stream across and produce a pronounced hissing sound. If an incandescent lamp be connected in series through a condenser on an alternating circuit, the lamp will light because of the surges induced in the plates, but owing to the interposed gap of the condenser, the same arrangement on a direct-current circuit will not produce light.

## METHOD FOR WELDING INDUCTION-MOTOR ROTOR BARS TO END RINGS

Considerable trouble was experienced with keeping the end rings soldered to the rotor bars of 10-hp. alternating-current induction motors used to drive our freight elevators. The soldering was done in




ROTOR PLACED IN CAN OF WATER

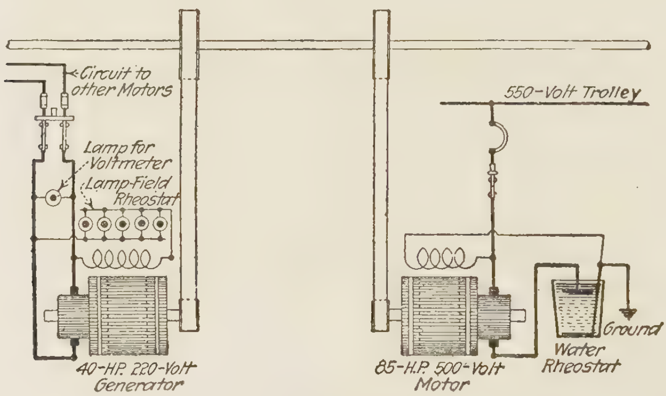
a local electrical repair shop, but as the price of labor and material went up so did the bills for repairs. It was decided to have the bars welded to the end rings if possible, but we were informed that this could not be done as the high temperature due to welding would destroy the rotor slot insulation. However, after some consideration of the matter it was decided to put the rotor into a tin can, made for the purpose and filled with water, as shown in the figure. The can was filled until the water came just above the rotor's slot insulation, leaving the end of the bars and end ring to be welded above the water. The bars were welded to the rings with Tobin bronze, the rotor dried out and balanced and the machine put back into service. The first machine that had its rotor conductors welded has been driving a freight elevator for about five months without any sign of trouble. The cost of welding was about one-third that of resoldering.

## OPERATING A 220-VOLT PLANT FROM 500-VOLT SERVICE

Fire had destroyed the mill and power plant of a factory. The factory was equipped with 220-volt direct current motors, current being supplied from the power plant. There was no other 220-volt direct-current service to be had, and the only current available was from a 550-volt direct-current street-railway trolley line.

Arrangement was made with the trolley company to use one hundred horsepower from their line, and an 85-hp. 500-volt shunt-wound motor without a starting box was secured. This motor was installed and belted to a lineshaft in the factory. Leaving the belt on the 40-hp. 220-volt motor formerly driving the shaft, the latter was driven as a 220-volt generator to supply power to the other small motors and lights about the factory.

As shown in the figure, a set of lamp sockets grouped in parallel was connected in series with the generator's shunt field, for voltage regula-

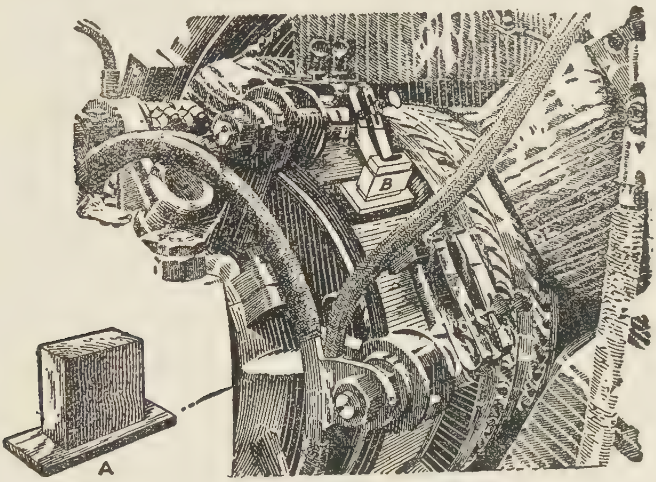



CONNECTION OF MOTOR AND GENERATOR

tion, and a water rheostat was used to start the 85-hp. 500-volt machine. Various-sized lamps were screwed in and out of the socket until the proper voltage was obtained. The switch and fuses used to protect the 40-hp. machine as a motor also served to protect it as a generator. There was no voltage release on the 85-hp. motor since it was started through the water rheostat; therefore it was necessary to keep an attendant near it all the time, as the trolley voltage was very unsteady. A circuit-breaker was installed for the protection of the 500-volt motor and a pilot lamp was used temporarily for a voltmeter on the 220-volt generator.

## PREVENTING SPARKING AT COMMUTATORS ON SLOW SPEED MACHINES

On slow-speed direct-current machines the peripheral velocity of the commutator is not high enough to throw off, by centrifugal force, the small particles of dust and dirt that may collect on the commutator surface; consequently, there is always more or less sparking due to the particles of dirt causing minute arcs across the mica insulation. Cleaning the commutator on a slow-speed machine is not very effective in relieving the sparking; although it gives temporary relief, the trouble soon appears again. The idea illustrated in the figure has proved to be



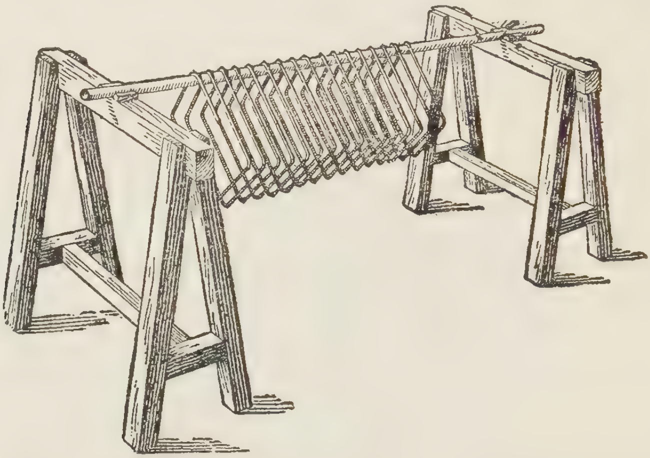
CLEANING BRUSH IN POSITION ON COMMUTATOR

very satisfactory in preventing the arcs in question. An additional brush-holder *B* is placed on one of the studs and turns in the opposite direction from the other brush-holder. In this brush-holder is placed a fiber or wooden brush, under the end of which is placed a piece of canvas three or four folds thick. The brush is made with an end considerably larger than the holder, as shown at *A*. This brings the canvas in contact with a greater area of the commutator. The canvas wipes the dirt off the commutator and prevents the pin arcs. If the commutator is of a width to warrant it, two or more of the piping brushes may be used. The canvas will have to be turned or changed from time to time, the frequency depending upon how constantly the motor is used and upon the amount of dirt suspended in the surrounding atmosphere.

## REINSULATING SERIES WINDING OF COMPOUND-WOUND MOTORS

Where it is necessary to rewind the series coils of medium- or large-sized compound-wound machines, it may be found difficult to obtain the proper size of wire. In such cases the coils can generally be satisfactorily reinsulated.

First the old insulation must be removed from the copper, which is easily done by subjecting the coil to fire and burning it off. This also



SERIES FIELD COILS SEPARATED READY FOR REINSULATING

anneals the copper and makes it easy to handle. Next the coil is placed on a long piece of pipe that is stiff enough to support it. Then the turns of the coil are very carefully separated, as shown in the figure, after which they can be conveniently insulated with linen tape and the turns may be reassembled as in the original coil.

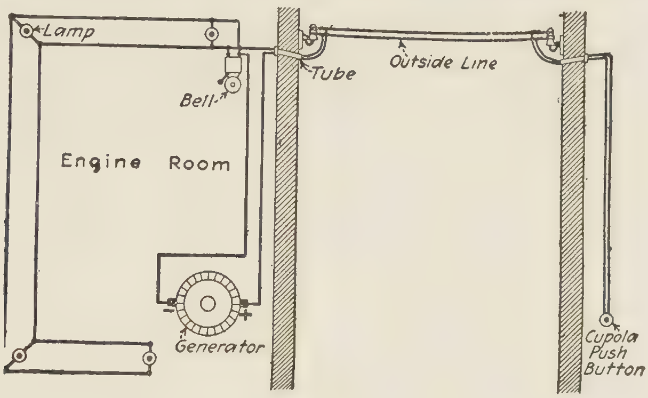
## A RELIABLE SIGNAL SYSTEM

The transmission of signals for air from a foundry cupola to the engine room, where the blowers are often located, is attended with more or less delay. A reliable and flexible signal system was installed in one plant by using the following arrangement:

Near the cupola was placed a push-button made with good, heavy contacts, so that the signals could be given with certainty. Around the cupola, where the wire was subjected to comparatively high temperatures, slow-burning insulated No. 14 wire was used; beyond this and across the yard weatherproof insulated No. 14. The wiring was installed as securely as for any lighting circuit, the joints soldered and properly taped, tubes

placed in the walls and the whole system well insulated. If the line is exposed to ice and snow, it is a good policy to use a No. 10 wire across the yard. Plenty of copper is a good feature, as it keeps down the volts drop in the line.

In the engine room the line was connected through a 10-in. fire-alarm type of gong to a 15-volt direct current generator. Where a generator is not available a storage battery can be used. The circuit was run to various points in the engine room and small receptacles installed, in which were placed low-voltage red lamps, so that if the engineer did not hear the gong he would see the lamps and know the gong was ringing. A diagram of the installation is shown in the illustration. This arrangement places all lamps and the gong in parallel but in series with the push-




WIRING DIAGRAM FOR SIGNAL SYSTEM

button, which must have good contacts to carry the necessary amperage at low voltage.

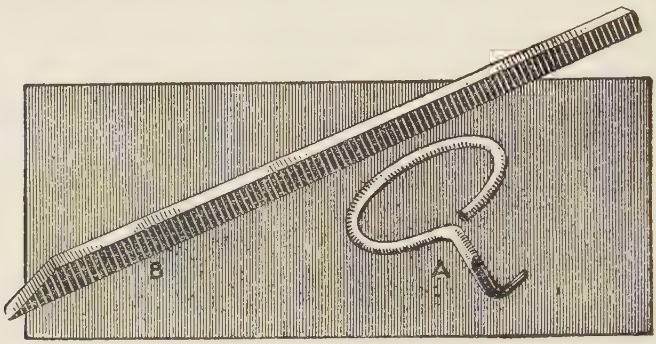
Thus, when the cupola button is pushed the gong rings and the lamps blink the signal, and even if the engineer is in a far corner of the engine room he can catch the signal without listening for the gong. If a battery is used for power supply, the best arrangement is a 4- or 5-ampere storage battery so connected to a direct-current generator that weekly charging is possible.

## REMOVING RETAINING WEDGES AND COILS FROM INDUCTION MOTORS

The following method for removing slot wedges and coils from stators has been used with considerable success. Nearly all insulating varnishes and paints are softer when warm than when cold, hence the coils and wedges can be removed more easily if the frame is heated. To loosen the

wedge a drift of iron or fiber about $^1/_{32}$ inch narrower than the slot and five or six inches long is placed on top of the wedge and tapped with a hammer. After the wedge has been loosened over its full length, it can be driven out by driving on its end with a metal drift.

In removing the coils the greatest difficulty is with the first one. In order to start this coil the hook tool, as shown at *A*, is used to lift the

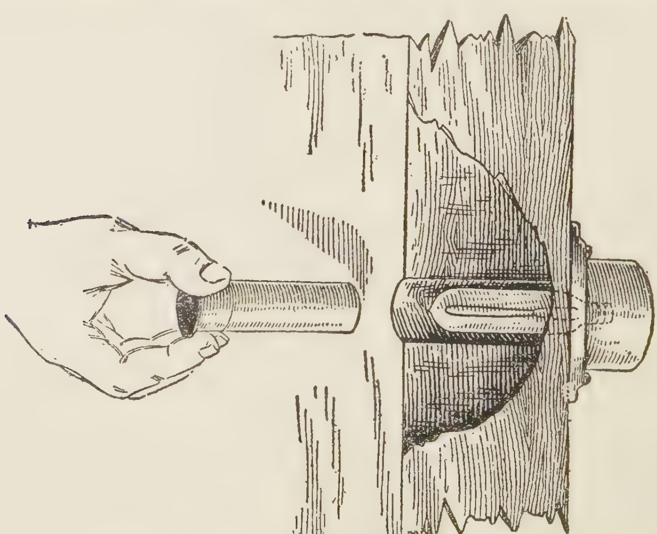



TOOLS FOR REMOVING COILS

coil ends as high as they will go. The pointed tool *B* is then inserted under the coil at the end of the slot, and the coil is raised.

## REMOVING SIGNAL LIGHTS WITH SHELL

Tubular signal lamps as used in remote-control switchboards and similar apparatus are commonly removed, when it is necessary to replace



REMOVING SIGNAL LAMP WITH EMPTY SHELL

or change them, by going in back of the board and taking off the removable socket to get at the lamp. It is sometimes difficult to locate the desired lamp from the back of the board, and frequently the back of the switchboard is not easily or safely accessible.

These indicating lamps can be far more easily removed by taking them from the front of the board with the aid of a 12-gage paper shotgun shell. The little colored glass window in front of the lamp can be easily lifted out with the fingers and an empty paper shell slipped over the lamp. The shell is of such a size that while the lamp will partly enter it, it fits tightly. It can then be easily removed by turning the shell, and a new lamp can be inserted in the same manner.

## RESTORING A BROKEN MOTOR FIELD CONNECTION

A three-horsepower shunt-wound motor had a field rheostat temporarily connected with it for the purpose of adjusting the speed. While standing unused a wire had become disconnected from the terminal block of the motor.

Fig. 1 shows the way the wiring was found. It was easy to see that the loose wire belonged on one of the armature terminals, but which one?

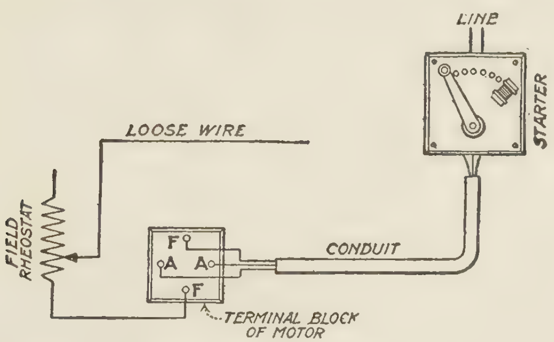



FIG. 1. CONNECTIONS OF MOTOR AS FOUND

In an effort to find out it was connected to one of the armature terminals and the motor started carefully without load. If started in the right direction, but was seen to be racing before the starter handle was in the running position. The field resistance was all out, so it was evident that an incorrect connection must have caused this behavior. When the wire was put on the other armature terminal, the motor operated properly.

Fig. 2 makes clear the reason for the racing. With the starter handle on the first point the motor had a fairly strong field with the incorrect connection, because it had impressed on it the voltage across

the starting resistance, which is a large proportion of the line voltage at the instant of starting, but as the motor starts and thereby reduces the current, the voltage across the field winding is greatly reduced until at the running position of the starter it is zero. Since the speed of a motor increases when the field current is decreased, the motor raced,

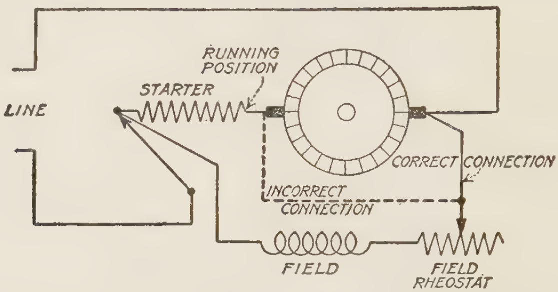


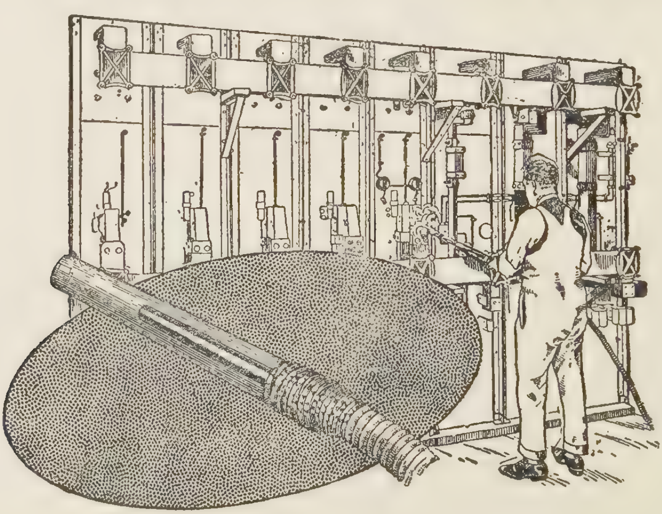

FIG. 2. CONNECTIONS OF MOTOR AS RESTORED

which fact was detected by the sound. Serious damage might have resulted if the starter resistance had all been cut out.

It will be noticed that with the correct connection the starting resistance is in the field circuit during normal operation, but this does not matter because the value of the starting resistance is only a small percentage of the value of the field resistance.

## SAFE SWITCHBOARD BLOWER

It is risky to blow down the back of a switchboard with an air hose and the usual metal nozzle, for no matter how careful the attendant may



SWITCHBOARD BLOWER AND ITS APPLICATION

be, contact is likely to be made with a live connection, especially when buses run along the back of the board. By placing a piece of water-gage glass over the nozzle as far as it will go, as shown in the insert illustration, and having the end of the glass tube beyond the end of the nozzle about two inches, the danger is eliminated.

The glass is secured to the hose by wrapping with adhesive tape.

## SHUNT AND SERIES WINDINGS OPPOSED

Opposition of the shunt and series windings of a compound-wound generator is not likely to be suspected until an attempt is made to put on a load. If the shunt winding is connected across the brushes, as in Fig. 1, the no-load series-field current will be zero. If the shunt winding is

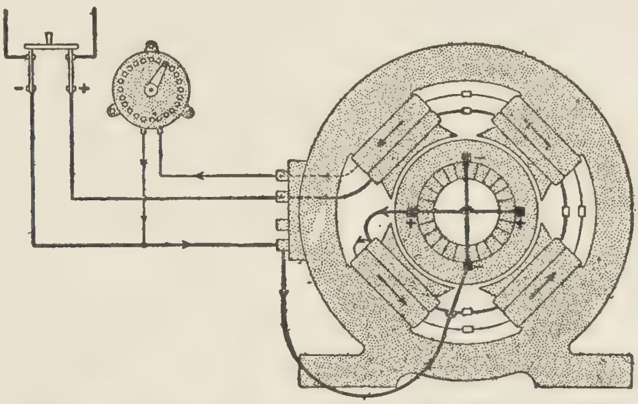


FIG. 1. COMPOUND GENERATOR WITH SHUNT WINDING CONNECTED ACROSS THE ARMATURE

so connected as to include the series winding in its circuit, as in Fig. 2, the no-load series-field current will be the shunt-field current, which will be too small to have appreciable effect through the few series turns. On applying a load, however, the increasing value of the series-field current increases the opposing series-field effect and a load much less than full load will be the limit to which the current can be increased and maintain the voltage at normal value by adjusting the shunt-field rheostat.

Complaint was made that the voltage regulator of an exciter could not maintain the alternator's voltage, because the exciter was too small.

On short-circuiting the series-field winding of the exciter, regulation became much better, and on reversing the series-field connections of the exciter, regulation became normal. This unit had previously been used as a motor.

The compound-wound motor was being applied to generator duty that called for the same direction of rotation as when used as a motor, and

the series-field connections should have been reversed at the time of making the change, but they had not been; therefore the shunt-field windings and series-field windings were opposing each other. The best that the regulator could do was to hold the shunt-field rheostat short-circuited, thereby giving maximum value of shunt-field current. Even

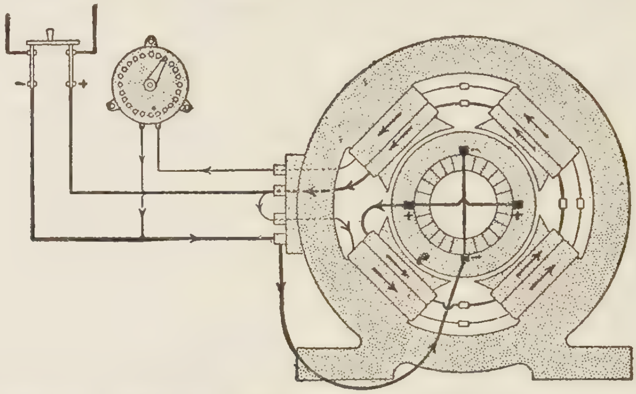
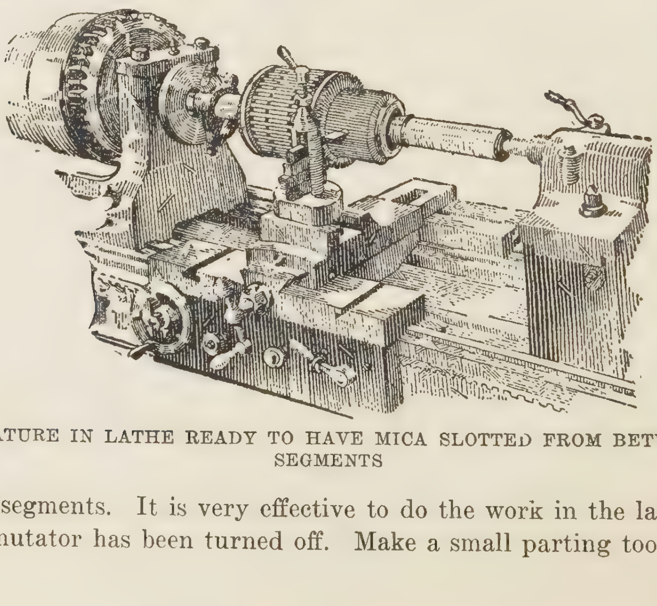


FIG. 2. COMPOUND GENERATOR WITH SHUNT WINDING CONNECTED IN SERIES WITH SERIES WINDING

this maximum value was not sufficient to maintain the voltage of the alternator.

## SLOTTING COMMUTATORS IN A LATHE

There are various devices for slotting the mica from between com-



ARMATURE IN LATHE READY TO HAVE MICA SLOTTED FROM BETWEEN SEGMENTS

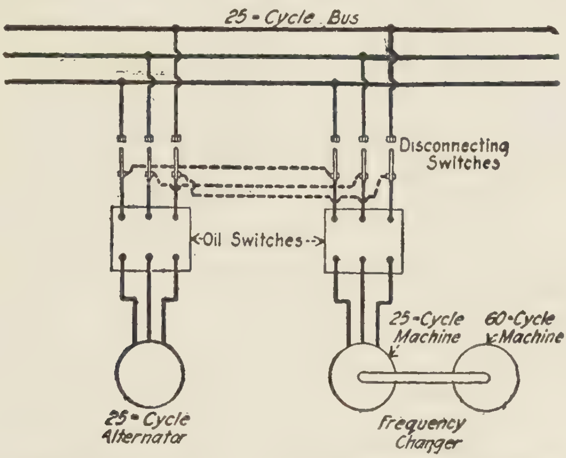
mutator segments. It is very effective to do the work in the lathe after the commutator has been turned off. Make a small parting tool, a little

narrower than the mica between the segments, and set it horizontally in the tool post, as indicated in the figure.

Take off the driving belt and put in the back-gear, block the dog in the faceplate slot with a wooden wedge to take up the lost motion, then turn the cone pulley by hand to bring the mica in line with the tool and push the tool through the mica by moving the carriage toward the headstock with the hand gear.

## STARTING A FREQUENCY CHANGER

A 2300-volt 60-cycle, 13,200-volt 25-cycle 1500-kva. frequency-changer set gave trouble in starting. There was a 100-kw. 125-volt




CONNECTIONS FOR STARTING FREQUENCY CHANGER

direct-current motor on the shaft for starting purposes, and this motor is connected to the exciter bus, but the necessary starting torque was so large that it required practically the entire exciter capacity of the station to start the frequency changer, and if started at any time except when the station load was low it caused an interruption to the service. In order to prevent interruptions to service, the following method of starting was adopted:

The leads from the 25-cycle side of the frequency changer were connected to the bus at a point close to the leads of a 2000-kw. 25-cycle turbo-alternator, the distance between the disconnecting switches of the two machines being about three feet. When the frequency changer was to be started, the alternator was shut down, if running, the disconnecting switches of the two machines were then opened and jumpers, as indicated by the dotted lines in the figure, were run between the machine sides of these switches. The oil switches were then closed, both machines excited,

and steam admitted to the turbine of the alternator. Since the machines were electrically tied together, they came up to speed together and the frequency changer was synchronized on the 60-cycle bus, after which the oil switches on the 25-cycle side were opened and the disconnects closed. The jumpers between the disconnects of the 25-cycle alternator and the frequency changer were left on except when work was being done on one of the oil switches, since these jumpers did not interfere with the normal operation of the machines.

## SWITCHING LIGHTING LOAD FROM TWO-WIRE TO THREE-WIRE SUPPLY

The lighting system in a mill was two-wire 110-volt and a breakdown service was desired.

At first it was proposed to install a transformer near the plant, because the mill was a considerable distance from the nearest secondary line; also, the load would heavily unbalance the three-wire secondary system, as well as necessitate running heavier wires than if the high

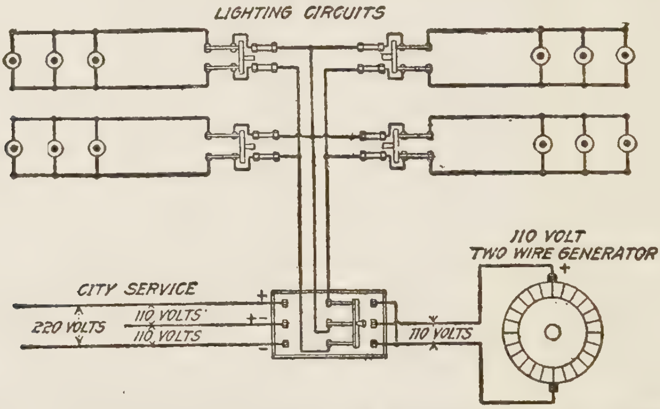



DIAGRAM OF CONNECTIONS FOR CHANGING FROM TWO-WIRE TO THREE-WIRE SERVICE

voltage was used. As the service would be required only a few times each month, a primary pole-top switch was to be installed so that by disconnecting it when not in use the transformer losses could be eliminated. It was finally decided to bring in the 110-220-volt three-wire secondary line from the street and change the wiring in the mill from two-wire to three-wire by running an extra feed wire from the switchboard to the different distributing boxes and distributing the load equally on each side of the three-wire feeder. A three-pole double-throw switch was installed, as shown in the figure, and the three-wire 110-220-volt service was con-

nected from the city secondaries as indicated. When the switch is thrown to the street service a three-wire 110-220-volt system is obtained, and when thrown to the plant generator the three-wire system is cut over to a three-wire 110-volt distribution. As will be seen, the voltage is 110 from each outside to the center conductor, but zero volts between the two outside conductors when the switch is thrown to the generator.

## TOOL FOR REMOVING FUSES

It is sometimes difficult to remove small inclosed fuses from their clips, especially if they happen to be in an inconvenient place. The illustration shows a very serviceable pair of fuse pliers made of a piece of fiber. Two holes about ¼ in. in diameter are drilled in a solid piece of fiber, and then the block is sawed open as shown, thus opening the pliers.


HOME-MADE FUSE PLIERS

Inserting a small steel spring as shown will keep them open normally and make them convenient to use with one hand. The distance *A* is about $^3/_{16}$ in.

## TOOLS FOR UNDERCUTTING MICA

For undercutting the mica in commutators a tool made as illustrated is handy. The slot in the holder is made as deep or deeper than the width of the hacksaw blade, with small bolts to clamp the blades at each end. Any depth cut desired can be made by adjusting the blade in the holder, but there seldom is occasion to move the blade. The handle part is cut away just enough to allow the fingers to pass over the commutator without rubbing. In undercutting commutators care must be taken that no rough edges are left after the mica is cut, but it is sometimes hard to avoid this, especially if it is an old commutator. These rough corners can be smoothed, after the mica has been undercut, with a V-shaped tool made of hardwood or vulcanized fiber, run between the segments as shown at *A*, and it does not spoil the bar. The front corner of the undercutter, which is made of fiber, can be used to smooth these raw edges.

Another commutator groover is made by cutting a $^3/_8$- or $^7/_{16}$-in. piece of fiber to the desired shape for a handle—the shape and size shown in Fig. 4 has been found convenient. Saw a slot in the lower end to

receive a short piece of hacksaw blade, which may be securely clamped in place with two bolts. The kind of saw, as to thickness and fineness, must be suited to the work.

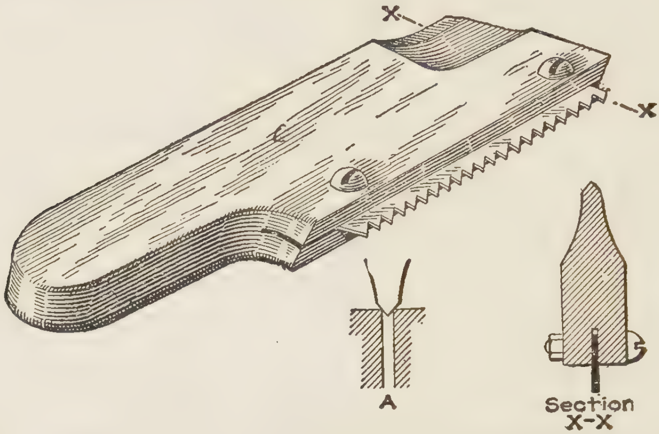



FIG. 1. SHORT SAW BLADE CLAMPED IN VULCANIZED FIBER HOLDING

A similar tool for use in cutting down the mica between commutator segments can be made by inserting a piece of hacksaw blade in a hardwood or fiber handle shaped as shown in Fig. 2. It can be made any size

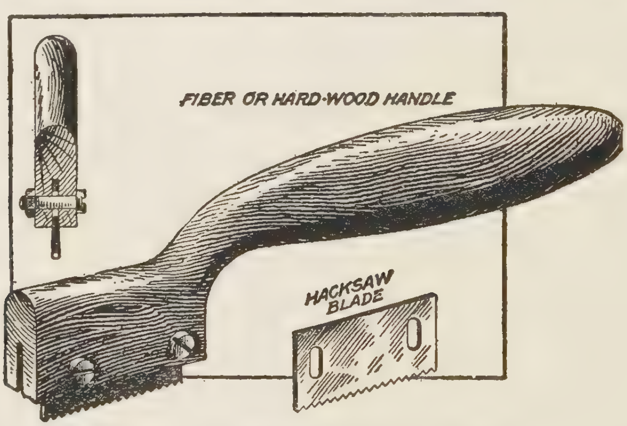



FIG. 2. COMMUTATOR MICA CUTTER

to fit the requirements. Two oblong holes are made through which bolts are passed in order to secure the hacksaw blade at any angle desired.

Another tool for undercutting mica is shown in Fig. 3 where *A* represents a steel straight-edge about ¼ in. thick and slightly longer than the length of the commutator segments and square at one end to butt up against the head or the commutator. *B* is the undercutting tool, about 12

in. long, made from a piece of $^5/_{16}$ hex. tool steel forged flat for about one-fourth of its length to a thickness at point *D* equal to the thickness of the mica between the segments. The "half-heart" shaped lobe *C* affords a bearing place for the fingers in using the tool.

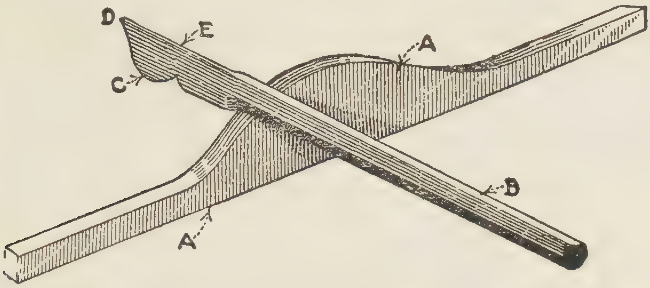



FIG. 3. COMMUTATOR MICA UNDERCUTTING OUTFIT

Lay the straight-edge on the commutator with its edge in line with the mica between the segments with the square end against the head of the commutator and hold it firmly with the left hand. Then, holding the tool *B* in the right hand, draw the point *D* along the mica the same as drawing a pencil along a ruler in ruling paper. This operation will start

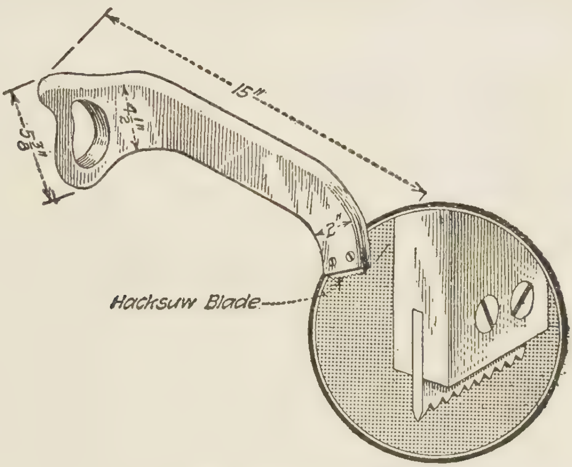



FIG. 4. COMMUTATOR-GROOVING TOOL

a nice groove in the mica without burring the edges of the copper on either side. After one or two passes the tool can be turned endwise with the point *D* down and the mica taken to any desired depth or a saw blade may be used to finish the groove. The disadvantage of a saw blade is that the set of the teeth burr the copper more or less, while with this tool all chance of a burr is eliminated.

The tool will also be found handy in raising coil leads out of the slots in the head of a commutator when unsoldering them preparatory to removing the commutator or making coil repairs. After heating the ends of the coils until the solder starts to melt, drive the point of the tool into the slot under the ends of the wires, with lobe *C* down, for a fulcrum, on the bottom of the slot, and the ends of the coils can be easily raised by a downward pressure of the hand. Square edge *E* can be used as a scraper for taking the surplus hot solder off the ends of the wires as they are raised.

## TROUBLE IN SYNCHRONIZING

After shutting down our two 250-kva. engine-driven alternators to repair a loose connection on the main oil switch, it was found, on starting up, that the generators could not be synchronized, and adjusting the governors, etc., failed to effect a cure. It was observed that one generator had a pulsating instead of a steady hum and concluded that an uneven air gap was the cause of the irregularity.

Upon inspection of the setscrews regulating the air gap, two were found loose, allowing the stator to shift a little with each revolution. After adjusting the air gap and tightening the setscrews, the generators synchronized as usual.

## TWO ELECTRIC ALARM DEVICES

The type of vacuum alarm shown in Fig. 1 is suitable for any system using a recording gage. A mercury cup is set in the base of the instrument, as shown, with one lead from a battery connected to it. The other lead is connected to the pen arm. A wire is fastened to the pen arm and extends almost to the surface of the mercury when the vacuum is normal. Should the vacuum go down, the hand will move to the left and the wire entering the mercury will complete the circuit and the bell will ring. The wire from the arm to the cup may be bent to give the alarm at any desired pressure.

Fig. 2 shows an alarm used on a transformer air-blast tunnel pipe. The air acting against plate *A* keeps it up, but if the air blast fails for any reason, the disk falls, completing the electric circuit and causing the alarm bell to ring.

## A VEST POCKET TESTING DEVICE

Most testing devices derive their power direct from the plant current supply through a lamp or bank of lamps and are a fixed or stationary

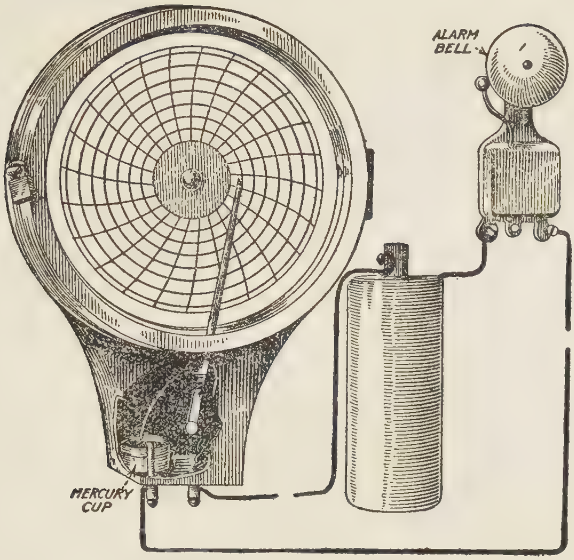



FIG. 1. ALARM BELL RINGS WHEN VACUUM IS LOST

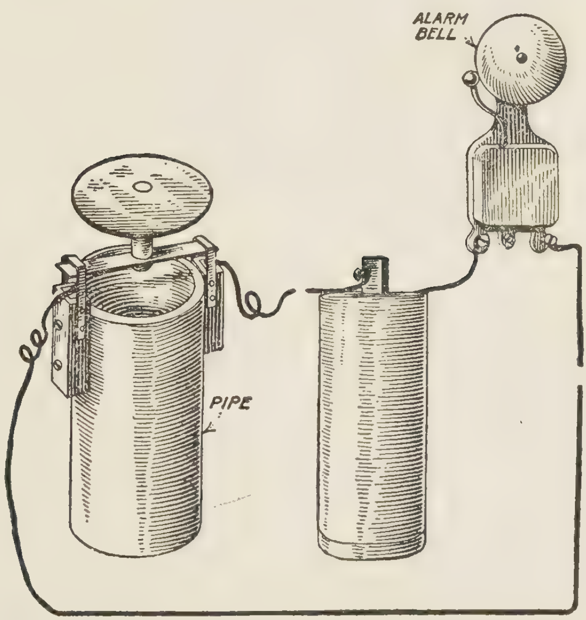
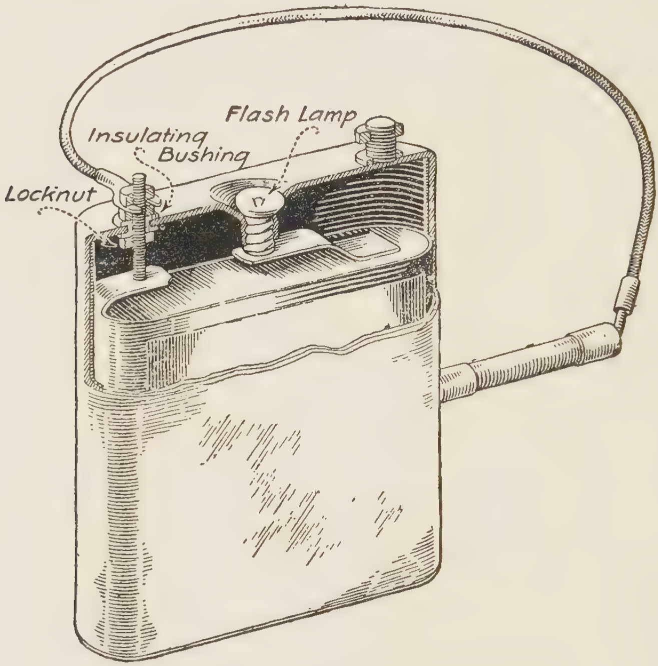



FIG. 2. BLAST FROM PIPE KEEPS BELL CIRCUIT OPEN

part of the plant equipment. A testing device that can be carried in the vest pocket may be used to test fuses, open-circuits, short-circuits or grounds—or for locating almost any trouble found in the everyday work of the electrical department of an industrial plant.

As indicated, the fuse-testing apparatus is made from an ordinary pocket flashlight. To the top of the flashlight case, after taking out the flash switch, solder a terminal as shown to the right. On the opposite




BATTERY FLASHLIGHT TESTING DEVICE

side drill a hole and insert another terminal. The left-hand terminal is insulated from the case and held in place by two nuts. This terminal comes in contact with the flashlight-battery terminal.

In the figure the equipment is shown used to test a cartridge fuse. By bringing a lead out from the right-hand terminal, tests can be made with the battery case in the pocket.

## UNSYMMETRICAL CONNECTIONS

An attempt to parallel two exciters resulted in the circuit-breakers opening and brushes sparking, and the automatic voltage regulator was put out of order. The regulator was found to be intact excepting that the relay contacts appeared to have been handling heavy currents.

Fig. 1 indicates the cause of the trouble; here the dotted line shows the two field rheostats to be connected together as a result of their windings becoming ground to their frame and of mounting the two rheostats

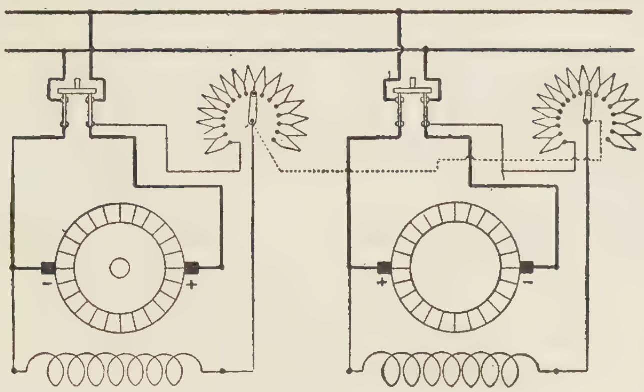



FIG. 1. CONNECTIONS WHEN TROUBLE OCCURRED

directly on the iron framework of the switchboard. Instead of connecting the rheostats to the same busbar, as indicated in Fig. 2, they were connected to busbars of opposite polarity, as in Fig. 1, so that the closing of the main switch of the incoming machine completed a short-

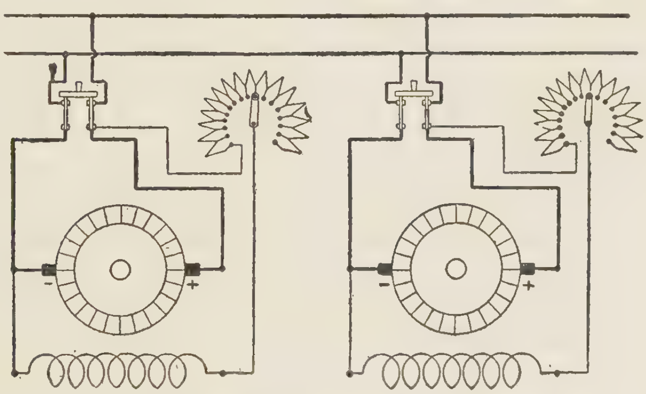



FIG. 2. CORRECT ARRANGEMENT OF CONNECTIONS

circuit through the two rheostats in series, further complicating the trouble.

In order to right matters, the grounds were cleared in the rheostats, their frames insulated from the switchboard frame and the connections changed to those of Fig. 2, in which the two machines are shown to be connected alike in all respects. This indicates that two machines should not only have the same polarity when they are paralleled but should

also be connected symmetrically so as to eliminate any complications that might arise from this source in case of trouble.

## WHEN THE GROUND INDICATORS DECEIVED

In a large generating station each alternator had two sets of ground lamps connected across its exciter; one set on the main switchboard, the other on a power-supply switchboard on the turbine-room floor. Each set consisted of two 250-volt lamps in series, with the wire common to both lamps grounded, as in Fig. 1. On one occasion the switchboard ground lamps of one of the units began to flicker, and a warning was given that the unit had a swinging ground on its field.

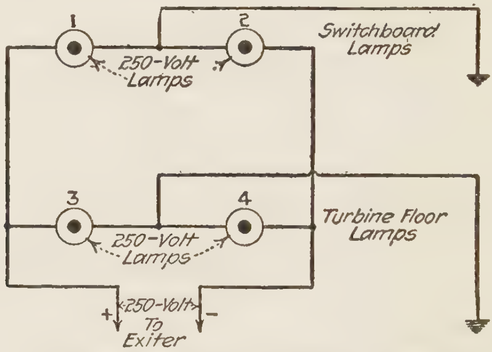



DIAGRAM OF GROUND-DETECTOR LAMPS

The ground seemed to clear itself in a short time, only to immediately return and become solid. The filament of lamp 1 was barely red, while lamp 2 was at full brilliance, indicating a positive ground. Both lamps normally burned at half brilliance since, being connected in series across a 250-volt circuit, they operated at only half voltage. At the time of the trouble no one gave thought to the scheme of connections, or remembered to check the switchboard lamps against the set in parallel with them on the turbine floor.

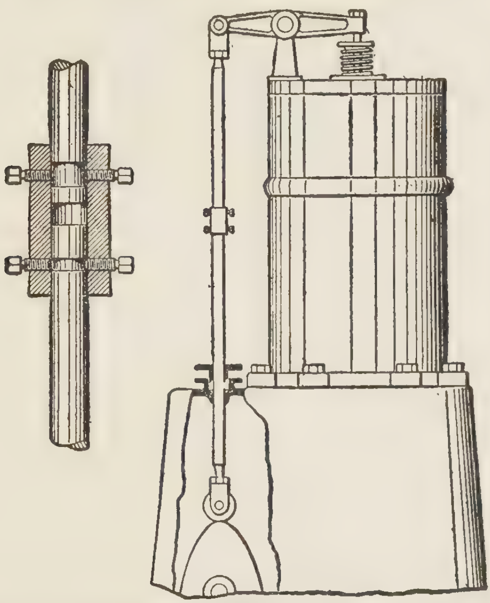
An electrician passing the turbine-room lamps noticed lamp 4 dead and lamp 3 dim. He twisted the dead lamp in its socket and both sets of lamps came back to normal. Vibration had loosened lamp 4 in its socket, causing the other three lamps to flicker; and when the circuit was broken at lamp 4, lamps 1 and 3 became dim and lamp 2 bright.

## SECTION VIII

# INTERNAL COMBUSTION ENGINE KINKS

### ADJUSTMENT OF VALVE-TIMING MECHANISM

In gas and oil engines it is customary to have the valve pushrod provided with right- and left-hand threaded ends. To obtain adjustment of the valve timing, it is necessary to stop the engine, open



COLLAR ON PUSHROD ASSISTS IN CORRECT TIMING OF INTERNAL-COMBUSTION ENGINE

the crankcase and loosen the locknut at the lower end of the rod before the rod length can be altered. The consequence is that the valve timing of the engine is always secured when the engine is cold. Owing to the variation in length of rod when cold and when warmed up, the timing as made when cold is never maintained. There is always some wear and backlash to distort the valve timing.

To allow the valves to be timed while the engine is running, make collars or sleeves, as shown in the sketch. The valve pushrod is cut in two pieces and grooves made in the ends inclosed by the collar. Two setscrews are fitted into the grooves, preventing looseness.

To adjust the timing, the locknut at the upper end of the rod is slackened off, the setscrew is loosened and the rod turned; this shortens or lengthens the rod as the case may be. As soon as the desired "lead" is secured the locknut is tightened and the setscrew adjusted.

## BEHAVIOR OF A SEMI-DIESEL OIL ENGINE

The seizing and sticking of the piston may occur from a faulty cooling system or poor bearing of piston on cylinder walls. The cooling system should be sufficient to cool the cylinders "stone cold" at the maximum load the engine will pull. For the volume of water passing through the jackets must increase as the load increases; or in other words, the temperature must be lowered until the piston stops pounding from heat. The piston should show a full bearing at full load and no high spots or other distortions. This may be remedied thus: The engine should be run at its maximum load and the piston carefully watched for pounding or groan, and removed at first sign of it, and all high spots filed down. This process should be repeated until the engine pulls its maximum load without any sticking or seizing.

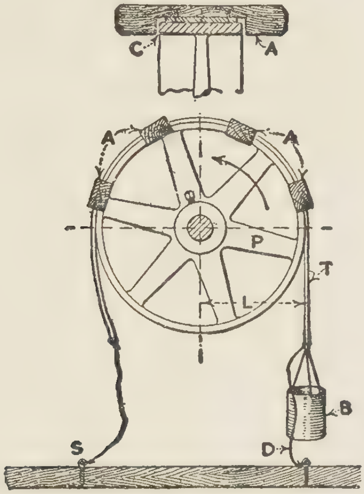
The cracking of exhaust and inlet port bridges is caused by unequal expansion when solid bridges are used between exhaust ports, and clogged circulation passages when water-cooled bridges are used. Solid inlet-port bridges do not break because they are not exposed to heat, but the exhaust-port bridges should be water-cooled to prevent cracking and the circulating water should pass these ports first before cooling elsewhere.

The fuel system requires careful attention, particularly the straining of the fuel of all grit and foreign matter. If this is neglected, all manner of annoyances will occur, for it breaks and misdirects the spray from the fuel nozzles. The fuel nozzles should be checked for spray at intervals. This is very important, especially where the spray is directed against some special igniting surface.

## BRAKE TEST OF SMALL GAS ENGINE

One of the simplest and best forms of brake for testing the power of a small motor is shown in the illustration. A piece of flexible belting is thrown over a pulley *P* of any convenient size secured on

the shaft of the motor. To keep the belt from sliding off the face of the pulley it may be tacked fast to light notched cleats *AA* that allow a little clearance at the edges of the pulley rim as indicated at *C*. Having rotation of the pulley in the direction indicated by the arrow, the tendency for the belt to become wound on the pulley is resisted by placing weights in a bucket *B*, or other convenient receptacle, attached to the side *T*. As a precaution against accident the ends of the belt are secured to the floor at *S* and *D* by stout flexible cords and these cords must be slack when the weight at *B* is observed for use in the computation. When the cleats and the ends of the belt are in position to balance without tendency to rotate the pulley




STRAP BRAKE FOR TESTING SMALL MOTOR

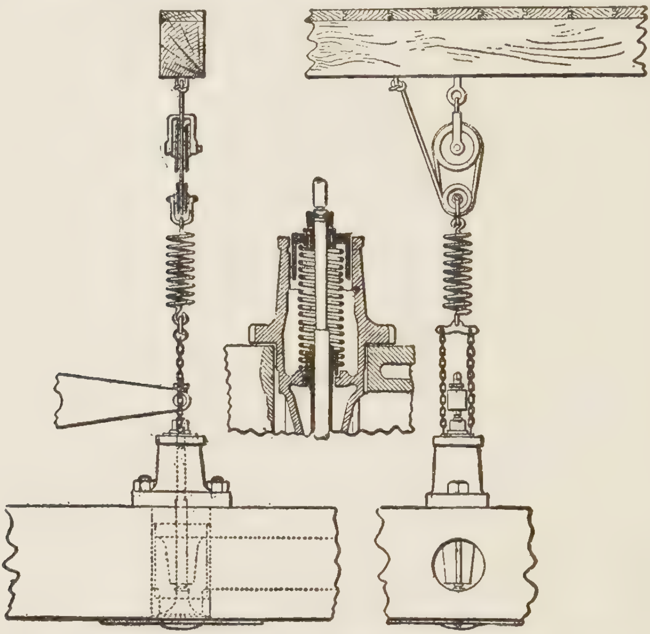
in either direction, the power developed by the motor in sustaining a weight *B* with slippage of the belt on the pulley would be the same as though the same weight were being raised at the same speed by the belt winding on the pulley. If the distance *L* represents the radius of the pulley plus one-half the thickness of the belt, in feet, the length of belt that would thus be wound up and the height the weight would be raised per revolution would be *L* feet$\times 2 \times 3.1416$. and this multiplied by the r.p.m. and value of the weight in pounds, would be the foot-pounds exerted per minute.

For example, if $L = 6\frac{1}{8}$ in., r.p.m.$=300$, and total weight $B=12$ pounds, the energy developed would be $\frac{6\frac{1}{8}}{12} \times 2 \times 3.1416 \times 300 \times 12 =$ 11,545.4 ft.-lb. per min., or $11{,}545 \div 33{,}000 = 0.34$ brake horsepower.

## BREAKING OF DIESEL-ENGINE VALVE SPRINGS

With certain makes of vertical Diesel engines considerable trouble is caused by the breaking of the suction- and exhaust-valve springs. Since it is impossible to operate the engine with a spring broken, such an accident entails the cutting out of this particular engine.

This trouble was solved in one plant in an unusual and clever manner. Directly above each valve an eyebolt was placed in the



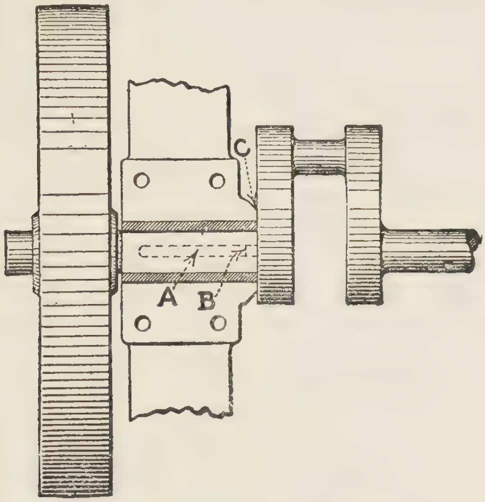
MAKESHIFT TO OVERCOME BROKEN-SPRING TROUBLE

ceiling. The valve dashpot piston or cap was drilled and tapped in two places and two small eye-bolts were inserted with locknuts on the inner side of the cap. If a spring broke, a spring with two hook chains was connected to the cap in the manner shown in the sketch, and a small tackle-block connected the other end of the spring to the ceiling eye-bolt. The proper tension could then be given the spring. In this way the valve continued to function until the engine could be shut down after working hours. Such a device can be fitted to any engine of either horizontal or vertical type.

## A CASE OF OIL THROWING

A gas engine of the inclosed crank-case type developed a bad case of oil throwing from the flywheel, and an examination proved that the

bearing had run hot enough to allow the babbitt lining to "wipe" over the oil grooves. There has been a groove in the bottom of the bearing, as shown at *A* in the illustration, and also a vertical groove in the end of the bearing at *B*, and the surplus oil supplied to the bearing had originally found its way back to the crank case through these grooves; but as both were now full of babbitt metal and the crank disk *C* rubbed




OIL GROOVES WERE CLOSED

the end of the bearing so closely that the oil could not get between, there was nothing it could do but run out at the other end of the bearing into the flywheel and from there to the four winds. Clearing the oilways corrected the difficulty.

## CIRCUMFERENTIAL CRACKS IN CRANKSHAFTS

Sometimes the shaft of an oil engine will develop a crack. To test for the depth of the crack rub Prussian blue mixed with kerosene into the crack, and then use gasoline torches to heat the shaft. This will give a fair indication of the depth of the crack from the amount of coloring matter that will ooze out. Then let the shaft cool while plenty of Prussian blue is again applied, as the contraction will absorb some coloring and upon heating the shaft again it will ooze out, thus giving a fair idea of the depth of the crack, thus checking the first test.

## CLEANING WATER JACKETS OF GAS ENGINES

For removing scale from a gas-engine water jacket if the scale is of lime formation use a gas blowtorch. A piece of $^3/_{32}$-in. copper tubing

is fitted with a ¾-in. tee. To the two open ends of the tee, run lines from the air starting tank and from the gas-supply line, both lines being equipped with regulating valves. When the gas is turned on and ignited and the gas and air valves are properly adjusted, the flame issuing from the tip of the copper tube will be at a white heat. When the flame is directed against the scale, the latter becomes very hot and, in expanding, drops off. Since it requires only a few seconds for the scale to become heated, the cylinder walls will not be injured.

## DIESEL CYLINDER-HEAD GASKETS

In one instance the heads on two 170-hp. Diesel engines had cracked and had been welded. The welded portion, on cooling, became somewhat warped, and gave a great deal of trouble by leaking. It was impossible to tighten down on the regular copper gasket sufficiently to prevent this leak.

This was overcome by using No. 6 copper wire. The bare wire was cut with taper ends and was placed so that the ring pressed along the outside edge of the gasket groove. After the copper ring was placed, a small asbestos rope was placed alongside of the copper gasket, and the two were then lightly coated with red lead. After the head was set on the cylinder, the nuts were tightened down in the usual way. The copper wire can be drawn down a great deal and easily conforms to any unevenness of the joint. The asbestos rope and lead, being on the inside of the joint, will collect small carbon particles and thus will stop any small gas leak. This method will not fail to make a tight joint. When a new gasket has been placed it should be tightened up again after the engine has been in operation a short time. This should be done while the engine is still hot.

The springs are not drilled for the weights, as this would weaken them; instead, each weight is built up of an inner piece, slit almost through with a hacksaw to take the spring, and an outer sleeve forced over the inner part and spring, thus holding both tightly together. The weights may be brass or steel. A stop collar on the shaft is necessary to limit the amount of governor opening, otherwise the springs might buckle; in any event, there should be no great strain on the springs when the weights are all the way out.

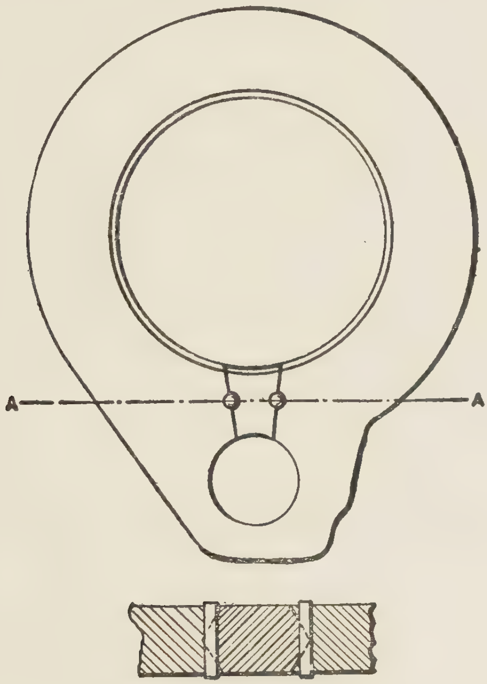
The easiest way to arrange the control lever is to attach a small brass roller to it, running on a steel stud; the roller fits into the grooved flange, and it and the lever are pushed back and forth as the governor weights move in or out. For a governer of this type a simple butterfly valve and lever, in the intake pipe, is probably best, though in many

cases connection can be made directly to the throttle lever on the carburetor.

## DIESEL CYLINDER-HEAD REPAIR

The welding of fractured Diesel cylinder heads is not an unqualified success. It requires an experienced welder, and if extreme care is not exercised the weld will show fractures on cooling.

Instead of welding, on one particular job a machine process was undertaken. A portion of the metal along the fracture was removed




Cross-Section of Wedge at A-A
DIESEL CYLINDER-HEAD REPAIR

by a shaper and the edges made wedge-shape as shown in the illustration. The surfaces were hand-scraped as was also the steel wedge which was to be inserted in the cavity. The wedge had a 1 to 24 slope and was sledged into place. Two dowel holes were then drilled and pins inserted. The two ends of the wedge were cut off to conform with the adjoining surface. At one end the exhaust valve seats on the wedge, and although the latter was steel, no leaking occurred at the seat.

It will be noticed that the inner, or wide, end of the wedge rests against the male portion of the joint when the head is placed on the

cylinder. Even if the dowel pins failed to hold, the male joint would prevent any movement of the wedge. The angular shape of the sides of the wedge effectively prevent any vertical motion. In operation the wedge is absolutely tight and shows no signs of fracture. The stress that exists in a welded bridge is not present.

## DIESEL-ENGINE POINTERS

In aligning the bottom shells of oil-engine main bearings, the thickness of each shell should be measured at the ends and center. If one bearing has worn thinner than the others, it should be shimmed up or the others scraped down.

Most oil engines run best with 0.004 to 0.006 in. clearance between the shaft and the top bearing. To secure this, lead wires can be used to check the clearance.

If the crankshaft has an endwise movement, the ends of the bearing should have babbitt rings run on them; steel washers placed between the crank throws and bearings are equally good. If not corrected, the sidewise movement will bell the crankpin bearings.

If a main journal or crankpin gets roughened the scores can be removed by careful filing and lapping with emery compound.

If a babbitt lining shows evidences of being cracked, it should be removed and rebabbitted at once.

After rebabbitting a bearing, it should be bored true before scraping, in order to preserve the alignment of the shaft and bearing.

## ELIMINATING DIESEL PISTON FRACTURES

In the operation of a horizontal Diesel oil engine it was found that the piston head or firing head burned out about every six months. The fracture usually occurred when the engine load was heavy. At times the fracture would open up enough to allow the flame to shoot back into the engine frame. The head was removable, being held in place by setscrews.

It was noticed that the fracture always started about three inches from the center of the head at practically the same spot. Apparently, there were two causes of the fracture. The design of the head included circular ribs at the front side. In cooling, after casting, these ribs developed stresses in the head. For several reasons ribless heads were deemed inadvisable and effort was directed toward effecting some arrangement whereby the fuel spray would not be centered on this one spot. It was believed that if the spray through the one hole in the spray tip struck this spot, the high temperature, much higher than that

of the surrounding metal, would cause expansion and contraction. This finally would result in a small fracture, which, as the gas blew through, would enlarge as the flame burned the edges of the crack.

Consequently, the single-orifice spray-valve tip was removed and a tip with six holes substituted. These holes were drilled slightly diagonally with the center line; the oil then issued in six streams, or sprays,

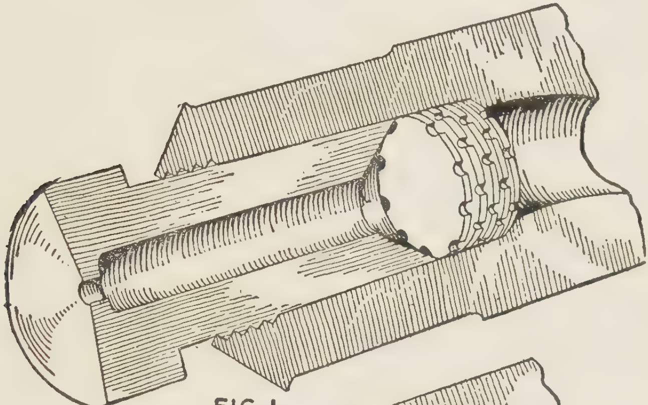


FIG. 1

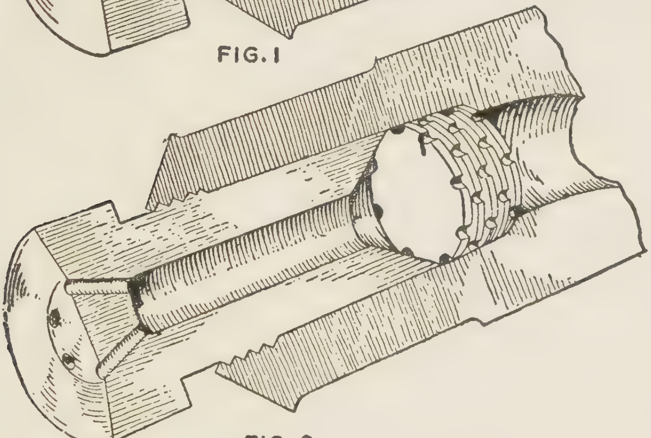


FIG. 2

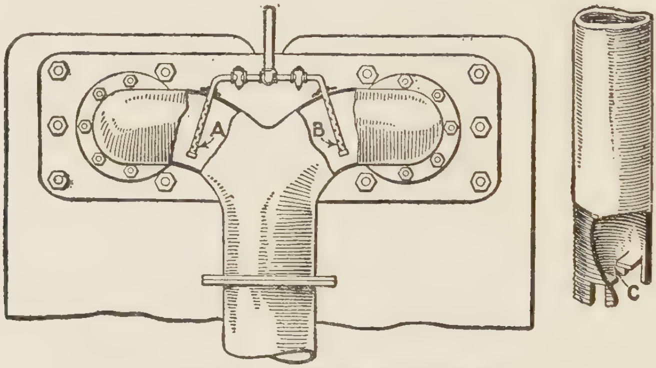
ALTERATION OF DIESEL SPRAY TIP

and covered a greater portion of the combustion space. This stopped further fracturing of the piston head. A decided improvement was noticed in the color of the exhaust. Originally, it was always slightly dark and the piston head usually was covered with carbon. With the new tip it seems that the oil is broken up better and is mixed with a greater amount of the air, giving better combustion. Figs. 1 and 2 show the fuel-spray valve with the old and new tips.

## EXHAUST-PIPE SPRAY PIPES CLOGGED

The illustration shows an exhaust pipe on a blast-furnace gas engine in which trouble was had with the sprays *A* and *B* clogging with mud and scale, and created a good deal of inconvenience.

The exhaust pipes are 26 in. in diameter, and a 1-in. pipe extends down into the exhaust, from the top, to a depth of 20 in., as shown at *A* and *B*. Each pipe contained thirty-six ¼-in. holes, the inner ends being plugged. This gave the desired spray effect as long as the small holes were free from mud, but after being in use awhile it was necessary to shut down in order to clean out the sprays.



OLD AND NEW SPRAY PIPES

The old spray pipes were removed, and instead of putting in another set of pipes of the same design, the internal edge of a 1-in. pipe was upset, as shown at *C*, where it enters the flange on top of the exhaust pipe. To get the best results with the pipe cut as at *C*, cut about 1½ in. of threads on the pipe, and with a hacksaw cut two slots in the end of the pipe, ½ in. deep and ¼ in. apart, and bend the two narrow strips in toward the center.

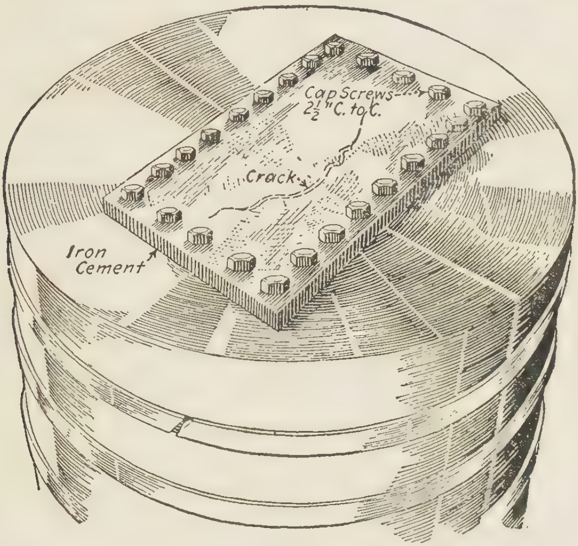
The pressure of the exhaust discharge, together with the split stream of water striking the exhaust at right angles, will make sufficient spray to keep the exhaust pipes cool.

## FRACTURED OIL-ENGINE PISTON HEAD REPAIRED

On Diesel engines it is customary to "sew" cracks or fractures in the piston heads. This is a somewhat difficult proceeding and too expensive for hot-ball engine pistons. The illustration shows a method that has been followed with success in several instances. The fracture is covered with a drilled ¼-in. boiler-steel plate and the piston head has

tapped holes for 3/8-in. capscrews to match the holes in the plate. A thin layer of iron cement is placed between the piston head and the plate, after which the capscrews are tightened.

To eliminate danger of preignition, due to the capscrew heads be-




PATCHED OIL ENGINE PISTON

coming incandescent while the engine is running, the heads can be cut off and the shanks of the screws riveted over the plate. If this is done, the holes in the plate should be counterbored to permit a better riveting.

## FUEL-OIL UNLOADING APPARATUS

Either of two methods may be used for unloading oil, dependent upon the location of the plant storage tank and the topography of the land. If the storage tank is underground or below the level of the railroad siding, the underneath unloading apparatus is cheaper to install and requires no pump to handle the oil. Fig. 1 shows this arrangement. The unloading piping is attached to the fuel line leading to the storage tank. The pipe line should be anchored, preferably to a concrete block, to prevent any displacement of the pipe line. Swinging joints may be used, but a ball-and-socket arrangement having a soft metallic gasket is the best. The two joints of pipe should be several feet longer than the distance to the center of the railroad track, as this allows connection without an exact placement of the car. The pipe is much superior to flexible hose. The pipe size may be as desired, although a diameter above two inches should be chosen. The tank coupling can be obtained from any supply house.

Where the storage tank is placed above the track level, the overhead unloading system is advisable. It has the advantage of providing ample clearance along the track. Furthermore, there is no danger of

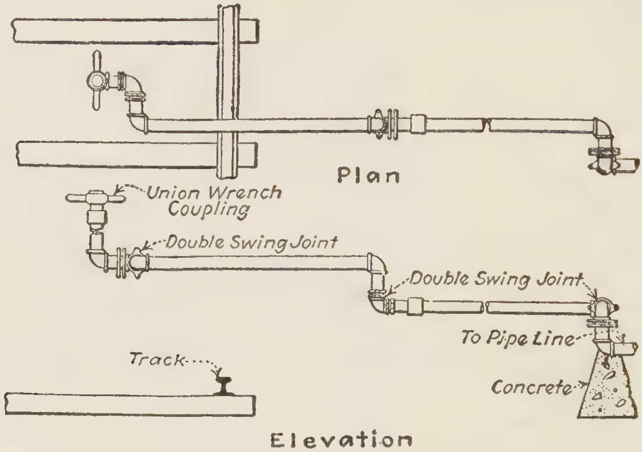



FIG. 1. UNDERNEATH UNLOADING APPARATUS

loss of oil due to defect in the unloading coupling. The platform should best be set at least eight feet from the near rail and should be ten to twelve feet above ground. Fig. 2 gives the various dimensions and shows

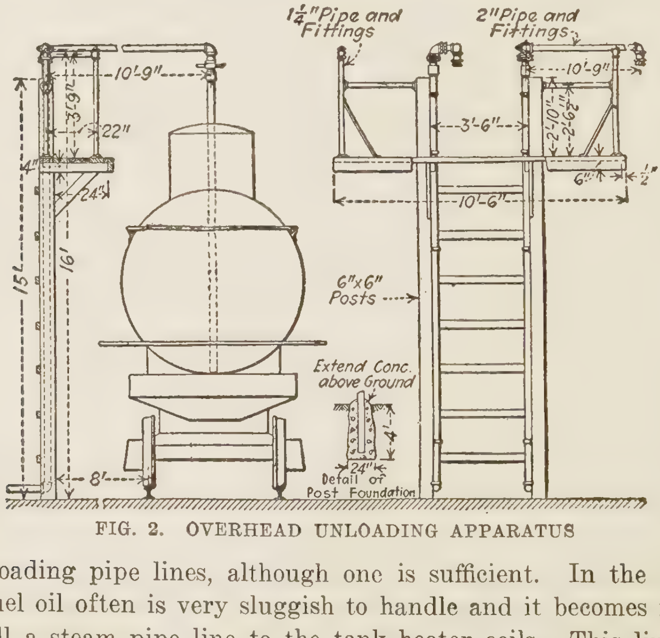
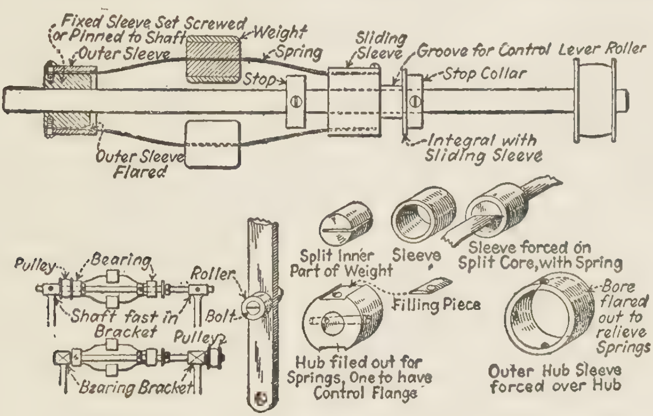



FIG. 2. OVERHEAD UNLOADING APPARATUS

two unloading pipe lines, although one is sufficient. In the Northern states fuel oil often is very sluggish to handle and it becomes necessary to install a steam pipe line to the tank heater coils. This line can be placed on this unloading rack without interfering with the fuel oil.

## HOW TO MAKE A SIMPLE GAS-ENGINE GOVERNOR

The sketches show the construction of a small governor of the Pickering type on which but little lathe-work is required. The size will depend on the speed at which it is to be driven and the amount of pull required to move the throttle valve, which will be of the plain butterfly type. The higher the speed the smaller the weights required or the stiffer the springs. Two brass or steel hubs are turned up and reamed to fit the driveshaft and filed off to take the governor springs. Two, three or four springs and weights can be used, according to requirements; heavy clock spring will answer the purpose for a small governor. The ends only of the springs are drawn; then they are held




DETAILS OF GOVERNOR CONSTRUCTION

in place and sleeves driven on over them and the hubs; holes are drilled through the sleeve, spring and hub and tapped for machine screws. The inner ends of the outer sleeves should be flared out to relieve the springs when the weights are all the way out. One hub is pinned or keyed to the shaft, while the other is a sliding fit and is provided with a grooved flange to take the control-lever roller; or else the shaft is fixed in place and the two hubs revolve on it, one having the drive pulley or gear integral with it and held between two collars which are fast on the shaft.

## MEASURING DIESEL-ENGINE CRANKPIN CLEARANCE

The average operator of Diesel engines "jumps" the connecting-rod big-end to determine the crankpin clearance. This is open to the objection that the result obtained is comparative, not exact.

To secure an accurate determination of pin clearance, either of two

methods can be adopted. In Fig. 1, which outlines a big-end bearing and crankpin, a lead wire *B,* or soft soldering wire, about 1/8 in. in diameter, is inserted in the bearing between the pin and the babbitt. The bolts are next tightened until the halves of the bearing meet on the shims, or distance pieces, at the junctions *AA*. After loosening the bolts, the wire, which has been flattened in the tightening process, is measured by a micrometer. If the thickness is not between 0.007 in. and 0.010 in., shims can be removed or inserted at *A* to bring the clearance to this value. The objection to this method lies in the difficulty of removing the wire. Usually, the pressure exerted on the bolts with the consequent flattening of the wire causes the latter to adhere to the

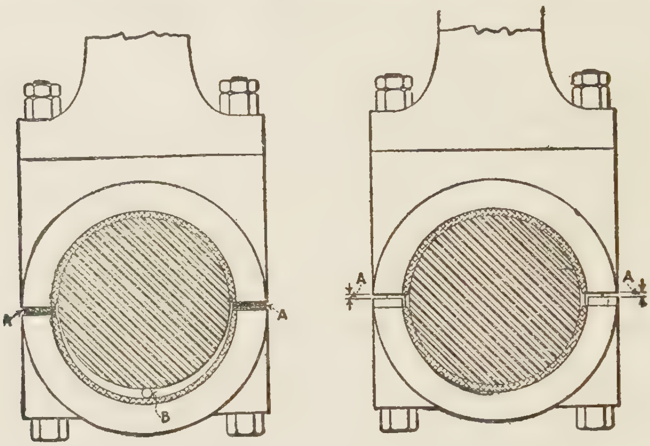



Fig. 1. By Lead Wire Fig. 2. By Thickness Gage
METHOD OF MEASURING CRANK PIN CLEARANCE

crankpin so that it is almost impossible to remove the wire without lowering the bottom half of the bearing.

A second method is outlined in Fig. 2. Here the bolts are drawn up as tight as possible and the opening at *A* is measured by a thickness gage. This width plus the desirable clearance of 0.007 in. is equal to the thickness of shims, or distance pieces, that must be inserted. If the halves of the bearing come together without shims, the bearing needs rebabbitting. In rebabbitting it is highly desirable to have ample shimming between the two halves. One-half inch on each side is not too much, since that will allow considerable wear before the bearing need be rebabbitted again.

## OIL AND FUEL TROUBLES IN A DIESEL ENGINE

Poor lubrication of pistons, accompanied by excessive wear on piston rings and liners, developed in a Diesel engine. Examination showed

that the crank-case oil was fairly good, but that the pistons were lubricated by an old-style force-feed lubricator. It was advised that a new-style lubricator be purchased and installed, as this is timed to inject the oil in synchronism with the piston movement. That is, the oil is injected at the dead-center position of the piston at the beginning of the power stroke, so that it acts to seal the piston rings and lubricate the liner at a time when the piston is doing the most work and lubrication is most needed.

Naturally, oil delivered by the old-style lubricator to the four openings in the cylinder liners sometimes is injected at the proper time; but as other pistons may have passed the openings, any oil injected at such time does no work and is of no benefit. Instead, it helps to form carbon in the cylinder. To obtain greater benefit, the piston should be in position to receive the lubricant on its outer circumference, directly between the third and fourth rings, while it is practically at a standstill. This is the dead-center position, and so the timed lubricator gives the most efficient service on Diesel engines. A set of gears attached to the layshaft is used for timing. From 15 to 20 drops of oil per piston per minute is average practice on engines up to 225 hp. at 164 r.p.m. Above this speed proportionately more oil should be used, 30 drops per minute for larger engines being about the maximum.

By means of a bent wire it was found that the suction check on the main fuel tank was badly adjusted, and this adjustment was remedied to prevent silt, sand and such rubbish from being picked up and carried to the auxiliary fuel tank. Considerable grit had been sucked up and no doubt had caused the fuel nozzles to cut badly. They had to be reground practically every two weeks, whereas once a month should be sufficient.

All piston rings on the engine were removed, all valves, fuel nozzles and seats ground in, and new fuel-cam noses put on to replace those that were worn. The gears were checked for correct timing, and the cylinder walls were smoothed up by scraping and polishing with emery cloth. The oil in the crank case was renewed, the bearings keyed up all around, the piston pins polished, all jackets and heads washed out with a hose and the water passages examined for scale. After assembling, the engine was started, and the indicator was applied to determine the compression in each cylinder. This was found to be excellent, and no further trouble from excessive wear occurred, while the fuel consumption was notably decreased. Part of the success in providing good lubrication on this engine was due to the change of oil.

## OIL-ENGINE CRANKSHAFT REPAIR

The crankshaft of a 180-hp. single-cylinder oil engine developed the two cracks indicated in Fig. 1. It was decided to weld the old shaft. With an acetylene torch a cut was made where the cracks were visible until it was certain that the bottom of the cracks had been reached, the cut varying from 1½ to 4 in. deep. These cracks were then filled in with an electric arc weld, using steel electrodes of as near the same kind of metal as the shaft as could be obtained.

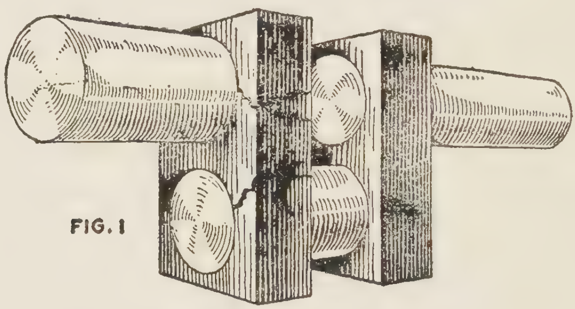


FIG. 1

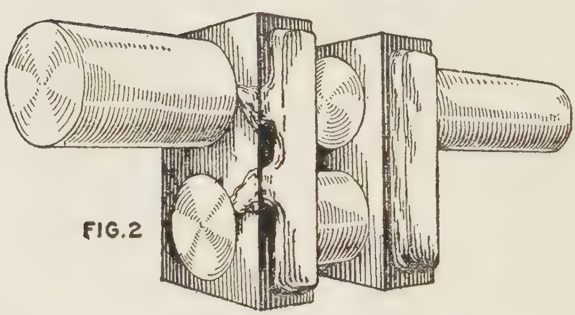


FIG. 2

CRANKSHAFT REPAIR

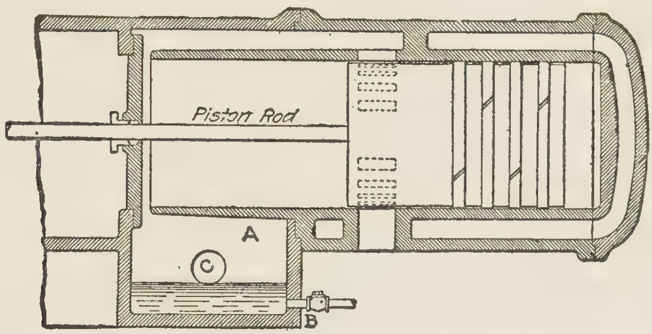
Then two pieces of round shafting 5⅞ in. in diameter were cut about 30 in. long and one placed on either side of the throw of the crank, as shown in Fig. 2, well overlapping the old cracks. These were built up with an electric arc weld until they appeared as integral parts of the shaft. The work was done without the labor of removing the shaft from the bearings.

## OIL ENGINE SMOKES

A surface-ignition or low-pressure oil engine had a decidedly smoky exhaust. The engine was of the hot-bulb type and had the crank end of the engine cylinder inclosed. This acted as the air compressor to

furnish the scavenging air to the power cylinder. The engine operated on the two-stroke cycle, and the cylinder construction followed the general lines shown in the illustration.

Examination revealed that the excess lubricating oil fed into the cylinder worked to the air end and dripped down into the airbox *A*. There was a plugged opening at *B* which had never been opened. The oil had filled this air passage, or box, until it was on a level with the air suction valve *C*. Thus, the air in passing through the valve picked up the oil and carried it in suspension. This air, after being compressed, blew into the power cylinder when the piston uncovered the air ports. The lubricating oil held in suspension was heated up by the




CYLINDER CONSTRUCTION OF THE ENGINE

exhaust gases and, as it passed out through the exhaust ports, produced black smoke. A ¾-in. drain line was run into the air passage three inches below the air valve. This drain had a check valve opening outward; the check allowed the oil to drain out and prevented the suction pressure from causing a reverse flow. Of course the open drain line caused a loss of air, but this was small and had no effect on the scavenging. The installation of the drain line caused the exhaust to clear up at once.

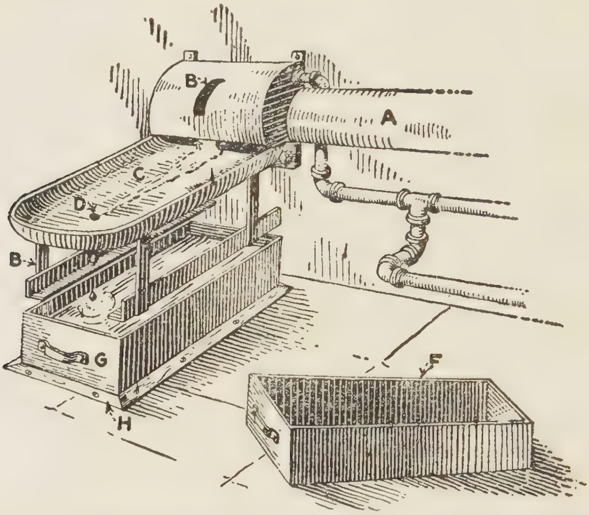
## OIL-PAN ARRANGEMENT FOR ASCERTAINING FUEL LEAKAGE

During economy tests on an oil engine it may be necessary to know the amount of fuel oil that leaks by the fuel-pump plunger. In one instance this pump was located over the camshaft *A*, and the plunger was driven by the cam *B*. The pan *C* was placed directly under the pump (not shown) and had been draining all the leaking oil through the hole *D* into the pail.

In order to ascertain the exact amount of oil leaking between defi-

nite intervals of time, the apparatus shown in the sketch was arranged The strips *B* were bent and fastened to the under side of the pan *C* by machine screws. Two light pieces of angle-iron were riveted so that the pan *F* would just slide into the pocket formed by these irons, which were made so that the pan fitted snugly enough to prevent sliding out due to vibration. Then the pan *G* was arranged underneath on the floor and held in place by wooden strips *H*.

With this arrangement the oil was allowed to leak into pan *G* until the start of the test. Then the pan *F* was slid into place and kept there for the duration of the test. For convenience the pan *F* was made to weigh an exact number of pounds.



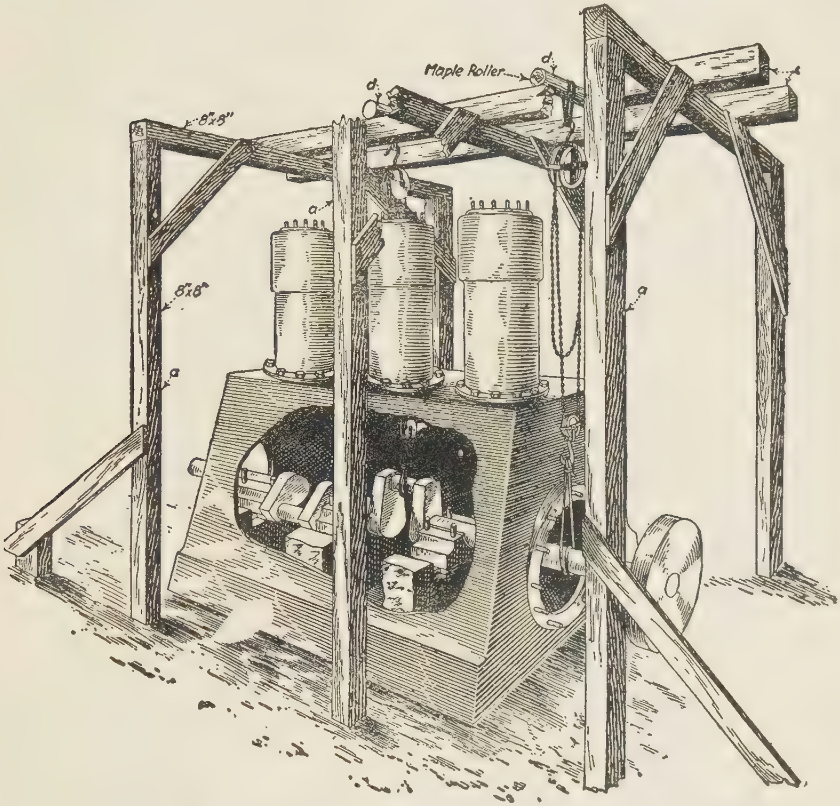

OIL-PAN ARRANGEMENT FOR ASCERTAINING FUEL LEAKAGE

This was found very convenient in determining the number of pounds of oil that should be subtracted from that drawn from the supply tank by the pump. In calculating the economy of the engine, this fuel leaking past the pump plunger is an important consideration.

## REMOVAL OF DIESEL CRANKSHAFT

It became necessary to remove the crankshaft of a three-cylinder vertical Diesel engine. This unit was provided with a box frame with circular flanges at each end, surrounding the shaft. The shaft had to be raised off the main bearings and moved longitudinally through the circular flange opening. Considering the diameter of the opening, which was 30 in., in relation to the extreme width of the crankshaft from pin to pin, 30½ in., the task was by no means an easy one. The

job was made increasingly difficult by the inability to remove the bearing-cap studs. Furthermore, the engine had been moved outside the engine room, so that there was no trolley chain hoist to do the work. A frame of 8 x 8-in. oak timbers was erected, as shown. At the tops of the vertical timbers *a*, ¾-in. holes were bored to a depth of 10 in. and threaded iron rods inserted. The three top cross-timbers *b* were




FRAMEWORK AND POSITION OF THE BLOCKS USED FOR THE REMOVAL OF CRANKSHAFT

bored and held fast by the bolts in *a*. Two 16-ft., 8 x 8-in. timbers *c* were spiked longitudinally on the cross-timbers.

Two 6-in. maple rollers *d* were placed on the timbers *c*, and rope slings were passed around them and fastened to two 4-ton chain blocks. Since the shaft weighed eight tons, the blocks were amply strong.

The main-bearing caps were removed from all the bearings, while the entire end bearing was taken out in order to provide room for the removal of the crankshaft. The bearing wedges were not touched, and

as the bearing was dowel-pinned against side shifting, the bearing could be replaced without realigning the shaft.

Rope slings were passed around the shaft and hooked to the blocks. The shaft was then lifted. Two workmen, using small bars, pinched the rollers along the timbers *c* until the block chains touched the sides of the top openings of the engine frame. The shaft was then blocked up and the rollers moved to a new position, whereupon the blocks were again fastened to the shaft and the endwise movement of the shaft continued.

The three sets of crankpin throws were of course 120 deg. apart, and this necessitated continual shifting of the shaft to allow the throws to pass the main-bearing studbolts.

## REPAIRING A CRACKED WATER JACKET

The water jacket of a gasoline engine was cracked in two places. One of the cracks was a very fine one, while the other one was more

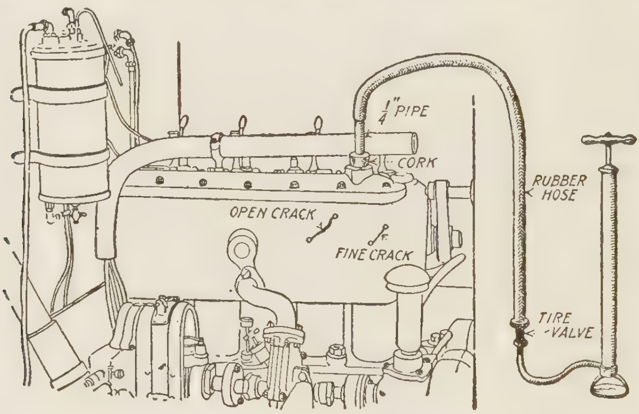



FIG 1


FIG 2

METHOD OF APPLYING THE COPPER SULPHATE

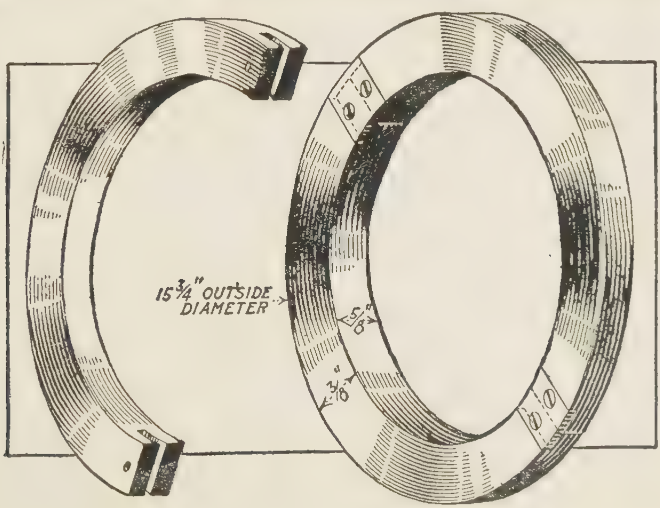
open. The larger crack was brazed in the following manner: First, to prevent the cracks from lengthening, holes about 1/8 in. in diameter were drilled and tapped at each end of the cracks and fitted with iron machine screws coated with shellac to make a tight fit. The wide crack was then prepared for brazing. With a sharp-pointed file the sides of the crack were carefully cut away to form a V-shaped groove, as shown

in Fig. 2. Along the bottom of the V, or crack, a very soft brass wire was placed and powdered borax sprinkled over it. The surface around the crack was first heated carefully with a blowtorch and the torch finally brought to bear upon the brass wire over the crack. With sufficient heat the wire was melted and fused into the crack.

The fine crack was not brazed but copper-plated. The water jacket was filled with a saturated solution of copper sulphate (blue vitriol) made by dissolving the crystals in warm water. At first the liquid leaked through the fine crack quite freely, but it was collected in a pan and poured back into the jacket again. After a time a coating of pure copper was formed in the crack, filling it up and making it tight. The job was considered done, but after the engine had been given a short run, a little leakage was still noticeable. To eliminate this fault, the copper-plating process was applied again by holding the copper-sulphate solution under air pressure by the use of a tire-inflating pump, as shown in Fig. 1. A few strokes with a tire pump was sufficient to create a pressure in the jacket, and when the copper plating was finished there was no leak even under pressure nor was there any leak when the engine was put into service.

## REPAIRING OIL RINGS OF GAS ENGINE

On examining the outboard bearing of a 650-hp. vertical gas engine that had been giving considerable trouble, it was found that the oil




TWO METHODS OF REPAIRING THE OILING RINGS OF A GAS ENGINE

ring was broken in two places. To make a new ring and raise the shaft to get the bearing out to put the new ring in place would take time.

The ring was 15¾ in. outside diameter, ⅜ in. thick and ⅝ in. wide. The broken pieces were removed and a piece cut out of one side of the ring at the break to a depth of $^5/_{16}$ in. and about ½ in. long on each side of the break. Next a ¼-in. hole was drilled and tapped, one hole on each side of the break. Pieces were then fitted in the offsets cut in the ring and drilled for ¼-in. screws and in line with the tapped holes in the ring. The lobs of the plates were countersunk on one side to allow the screw heads to come flush with the metal. The plates were next secured to the ring by screws. All were filed to the same radius as the ring, both inside and outside. The ring was then put in place.

Another good way to repair broken oil rings of small size is shown at the left of the illustration. For rings that have not enough stock to cut out and set in a piece, as in the first instance, a good way is to split the ring in the center of the width, as shown. This is done on each broken end. The corresponding ends are then put together and pieces of tin inserted in the slots and held in place by drilling through the side of the ring and the tin keepers, using a small piece of copper as a rivet to hold the tin and ring in place. If tin is not at hand, a piece of a saw blade can be used after drawing the temper.

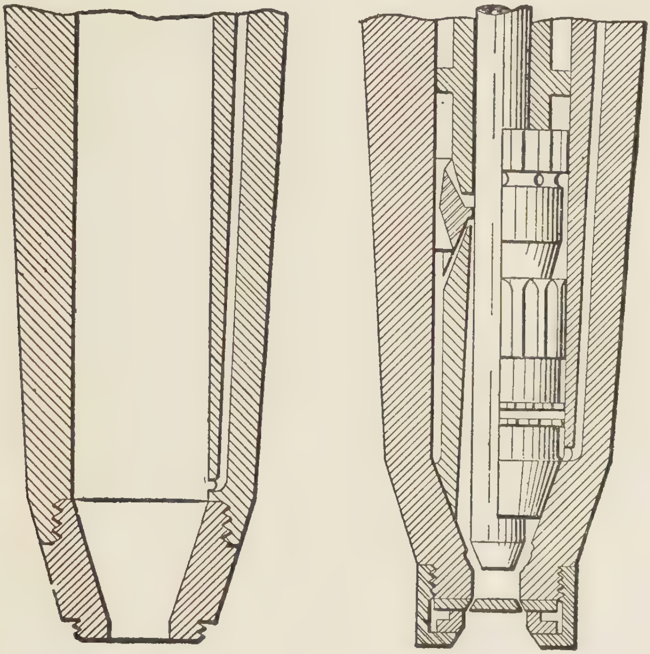
## REPAIR OF DIESEL FUEL VALVE

With the closed-nozzle type of fuel valve the needle often scores the seat. Minor scores or cuts can be removed by grinding. If the valve seat is very rough, it may be repaired by re-reaming. Frequently, the wear is so very rapid that constant reaming finally allows the tip of the needle valve to protrude and strike against the flame plate.

When the valve-cage seat has worn to such an extent that the needle valve tip protrudes, some engineers discard the cage and obtain a new one. At a small expense an engineer recently repaired several fuel-valve cages, making them fully as serviceable as new ones.

Fig. 1, the illustration at the right, shows where the valve seat began to cut. When the valve functioned no longer, the cage was removed from the engine. The end was cut off, bored and threaded. A tip was turned out of steel and screwed into the cage, as shown in the drawing to the left. This repair enabled the operator to

avoid the purchase of a new cage. The cost of reparing was about five dollars.



## SEMI-DIESEL AND HOT-BULB ENGINE SUGGESTIONS

When installing an oil engine, have a foundation of sufficient size. Many engines are damaged from severe vibrations which would be eliminated by using more foundation material.

In placing the engine on the foundation, the engineer should be very careful about getting the engine level. The top surface of the bearing housings are always planed true. The spirit level can be placed on these surfaces.

In those engines where the air is drawn from under the base cement dust will often be drawn into the crankcase. After grouting the engine, a couple of gallons of linseed oil poured under the base will prevent cement dust.

In adjusting the main bearings, always leave a play between the shaft and top bearing of 0.01 inch.

There is always a side play of the shaft. If this exceeds $^1/_{32}$ in., it must be taken up. The best way is to put in new air-seal rings between

the crank throws and the bearing ends. If new air-seal rings cannot be secured, a thin brass sheet can be sweated onto the worn ring.

Never run the crankpin bearing as snug as with a Diesel. A clearance of 0.01 inch is not excessive. If the brass can be moved a slight amount with a pinch bar, the play is ample. Examine the crankpin bearing bolts often. There are many cases of broken crankcases and pistons resulting from neglect of the bolts.

Never let lubricating oil collect in the crankcase. It mixes with the crankcase air and enters the cylinder, causing a smoky exhaust. If in large amounts, it will cause the engine to race since it will burn the same as fuel oil.

## SUGGESTIONS FOR THE SEMI-DIESEL ENGINEER

On starting the engine, do not inject too much fuel oil. Two strokes of the hand lever should be sufficient. If an excessive amount of oil is used there is great danger of blowing the cylinder-head joint.

In old engines where the usual copper gasket fails to keep the head joint tight, try using asbestos wicking braided into a rope. This should be soaked in salt water and then covered with graphite and oil before using.

In installations where the starting torch is fitted with a heating coil, small carbon particles will choke the coil; a spare torch should be always on hand. The coil can be cleaned by soaking in lye water and then blowing out with air.

In starting a semi-Diesel engine, the torch should be forced to cause the ignition plug to be heated in the shortest possible time. Slow heating causes the entire cylinder to become hot. Since no cooling water is flowing, the cylinder-head gasket is often ruined by this.

The proper temperature of the ignition device, whether it be a bulb or plate or pin, depends on the compression pressure carried. In engines having a pressure of 70 to 90 lb. the bulb must be cherry red. Higher pressures require lower temperatures; in engines of 160 to 200 lb. compression, the bulb of plate need never be other than black in color.

If the crankcase is not kept drained of lubricating oil, the engine may run away when the load is thrown off. The oil will be carried into the cylinder by the scavenging air.

When a heavy fuel oil is used, a considerable residue will drip down into the crankcase of vertical engines. If this tarry substance is not removed, it will work into the crankpin oiling device. Many crank brasses are ruined because of this carelessness.

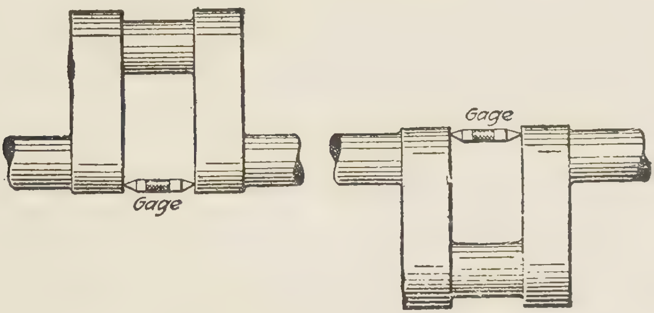
On two-cycle engines the piston-pin brasses wear as rapidly as do the crankpin bearings. The former should be adjusted as frequently as the latter.

The piston-pin setscrews often work loose. If the pin is allowed to shift sideways, the cylinder walls will be scored.

In some engines a brass scraper is placed in the end of the piston pin. The scraper picks up the lubricating oil from the cylinder wall and forces it through a passage onto the piston pin. This scraper often becomes choked with tar. It should be cleaned very frequently.

## TESTING CRANKSHAFT ALIGNMENT

A method of testing the alignment of gas-engine crankshafts is to place the crankshaft on its top center and with a micrometer gage, gage between the crank webs at the bottom. Turn the crankshaft



TESTING CRANKSHAFT ALIGNMENT

around till it is in its bottom position and gage again. When the amount that some of them will open is observed, one will not be surprised that so many gas-engine crankshafts break. Usually, it is the bearing on the driving side that is low.

## *SECTION IX*

# KINKS IN CONDENSERS

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### CLEANING SURFACE CONDENSERS

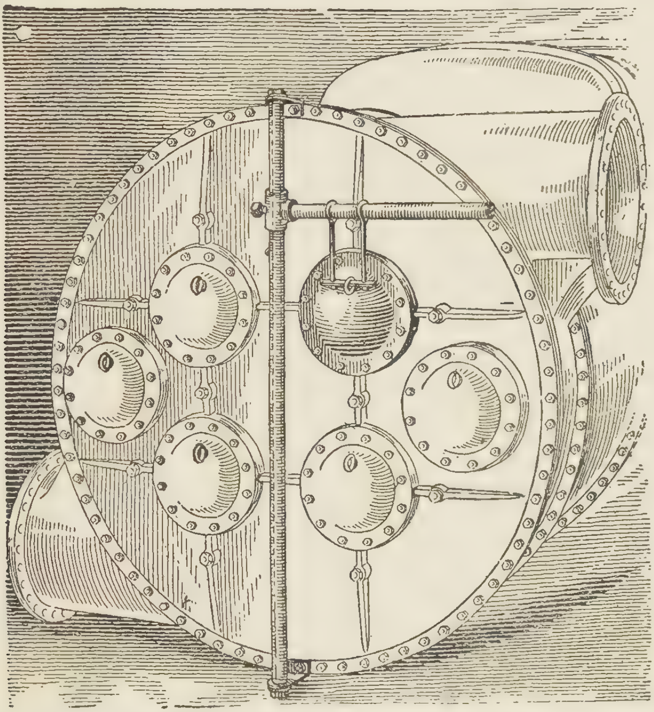
Where the circulating water contains scale-forming matter, the cleaning of the condensers is governed by the amount of scale or deposit, the interval of time elapsing between cleaning and the length of time allowed for cleaning. When the time is short and the scale or deposit is slight, a solution of one part commercial muriatic acid and four parts water is an excellent medium for cutting out the deposit.

After cutting out the condenser, thoroughly test it for leaks by filling the steam space with water or by means of the vacuum pump. After all leaky tubes and packing ferrules are made tight, close off the inlet and discharge, and after providing ample vents on both ends of the water space and a steam connection somewhere on the bottom, allow the solution to run in slowly from a barrel above the condenser until the condenser is full, then turn on steam enough to cause the solution to boil slowly. The vents allow the gases to pass off and prevent the accumulation of undue pressure in the water space. The heat of the steam assists the acid in its action and should be kept on as long as possible, and upon draining it will be found that the tubes are as clean as new. If part of the circulating water is used in the boiler feed, it is advisable to flush out the water space to the sewer before putting the condenser in operation.

To clean the steam space of grease or sludge coming from the exhaust steam, fill the space with a strong solution of soda ash or caustic soda and water. (The strength of the solution should be governed by what it will take to cut the grease.) See that the steam space is also properly vented as before and turn on steam and leave it on as long as possible. Be sure to flush out thoroughly with clear water, if the condensate is used in the boiler supply, before starting. Where the deposit in the water space is hard, a reliable air or water turbine drill is a good means of doing the cleaning.

## CRANE TO HANDLE CONDENSER MANHOLE PLATES

It is difficult for one man to remove the manhole plates of a large condenser. The illustration shows an easily made device for this purpose. Two angle brackets are fastened to the condenser shell by drilling through and tapping the holes or using bolts. A rod of the proper length is passed through a section of pipe cut long enough to reach



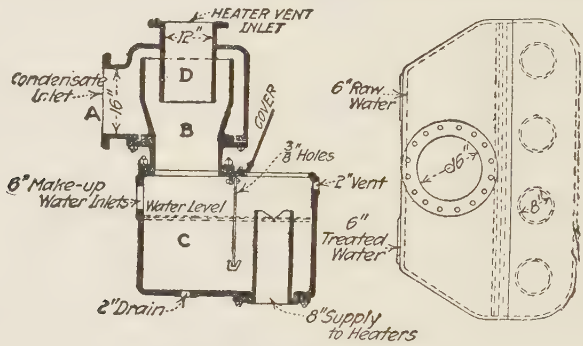
HOME-MADE MANHOLE PLATE CRANE

from the top to the bottom bracket. A washer and nut are put at the top and at the bottom of the rod and the nuts are tightened, allowing the pipe just enough freedom to swing easily. A tee and a section of pipe, heavy enough to hold the condenser plate, form the arm of the crane. A setscrew in the back of the tee fastens it to the upright pipe at the desired height. Two eye-bolts on the swinging arm and a connecting piece put through the handle in the plate make it possible, after taking the weight on the crane, to remove and swing the plate to one side. Instead of the two eye-bolts a rod with a hook at the end can be used if desired.

## DIVIDING BOX WITH CONDENSING HEAD

A dividing box with condensing head, designed for use in power stations using two or more open-type feed-water heaters, is shown in the drawing. The dividing box is designed to distribute the water equally to any number of heaters. The purpose of the condensing head is to condense the large quantity of exhaust steam going to waste through the vent pipes, and at the same time it keeps the heater free of air.

In operation the hotwell pumps discharge the condensate water through the 16-in. inlet *A*, where it rises up and flows over into 21-in. cone *B* and into dividing box *C*. As the water falls through the cone,




DETAILS OF DIVIDING BOX

it forms a vacuum which falls over the steam and air in the vent pipes through the central 12-in. opening *D*, condensing the steam and allowing the air to escape through the perforated plate *E* and the 2-in. vents in the dividing box.

Two make up water inlets are provided in the dividing box, permitting the treated water to be controlled by a float box at the nominal water line of the heater and the raw water to be controlled by a float box operating at a lower level. In ordinary operation only treated water is fed into the dividing box, but should the water level in the heater be pulled below the normal line at any time the raw water is admitted until the normal water line is reached.

## EVIDENCE OF LEAKY CONDENSER TUBES

There can be quite a fair leakage in a condenser without the vacuum being affected, and at the same time the excess or extra water may easily escape notice. There is always a certain amount of makeup water required, and in the average plant a lot of water is wasted through the overflowing of the feed-water heater.

If the circulating water is salt, a small leak can readily be detected by drawing about a pint of water from the hotwell and adding a drop of silver nitrate solution, about 1 in 20. If there is a small leak, the water will become milky when the solution is added. A little experience will teach one how serious the leakage is. The average air pump can handle a little air leakage from tubes, and the condensate pump can take care of a little extra water without the vacuum suffering.

## HANDY TOOLS FOR SURFACE CONDENSER WORK

Considerable time can be saved when removing, replacing and repacking surface condenser tubes if the proper tools are utilized. The tool first used will depend upon whether the tubes are expanded into the tube head or whether the packing is held in place by the ordinary threaded and slotted ferrule. If expanded into the head, the first tool needed will be an ordinary rectangular ended calking tool with which the slight flange or bell of the tube can be turned in. This tool can be easily forged from a piece of hexagon tool steel as shown at the top of the illustration, the working end being about one-quarter inch thick by three-quarters inch wide and length of an ordinary chisel.

The second tool, called the backing-out tool, is made from a piece of cold-rolled steel, the diameter being the same as the outside diameter of the tubes. One end is turned down for two or three inches to a diameter slightly less than the inside diameter of the tube, as shown at *A*. When the tool is driven into the tube, the shoulder will force the tube out of the head enough to permit of its being removed.

In case the tube ends are packed, a tool similar to *A*, with a cross-pin inserted just against the shoulder *C* and made to fit the slot in the ferrule, is used, the diameter of the smaller end being slightly less than the inside diameter of the tube, and the diameter at *D* back of the shoulder the same as the outside diameter of the ferrule. The head end can be made hexagonal so that a wrench can be used on it, or it can be drilled as shown with two holes at right angles through which a bar can be inserted for turning it to back out and screw in the ferrules.

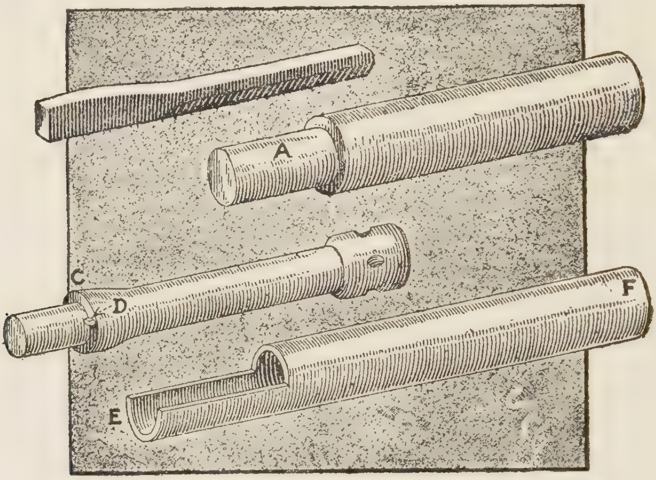
In replacing the tubes it is sometimes necessary, if they are of an unusual length for this diameter, to insert a rod into the tube of slightly greater length than the tube in order to feed it through the baffle plates and into the opposite head. In case the end of the tube sags down, an ordinary piece of round iron can be slipped through the tube sheet and into the tube, permitting the feeding of the tube into the tube sheet.

The next operation is to expand the tubes into the sheet with a regular expander for this purpose, or in the absence of one, the tubes can

be swaged into place with a bluntly tapered tool that will expand the end of the tube while some one holds a backing-out tool against the other end.

If the tubes are packed in with either corset lace or fiber ring, a packing tool is made by taking a piece of the tubes in use and grinding away one-half of it for a length sufficient to reach the bottom of the stuffing-box and then expanding the remaining half to a circumference slightly greater than the tube but just so it will go into the packing space.

The bottom illustration shows the manner in which the tube is ground away so that the *E* presents a semicircular end which will enable one to pack the tube ends in a rapid and satisfactory manner by driv-



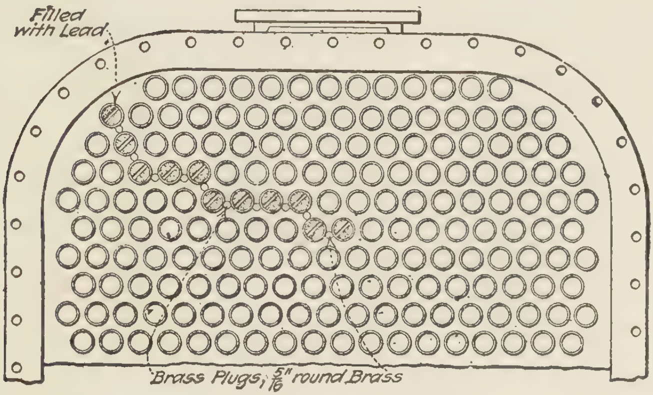
TOOLS FOR CONDENSER WORK

ing on the end *F* lightly with a hammer. After sufficient packing is in, the packing wrench *C* is brought into use and the ferrule is tightened up, ready for a test to see whether a tight job has been made.

There are two methods of making this test. One way, which usually requires considerable time, is to fill the steam space with water and look for drips from the tube ends. A more speedy way is to start the air pump, which will exhaust the air from the steam space and at the same time cause air to be sucked in through any ruptured tube or leaky packing to the extent that it can be easily heard and traced by simply running the hand flatwise over the tube ends; or if there should be too much noise from the outside, by using a candle over the ends of the suspected tubes, the flame of the candle being drawn in wherever there is an air leak of any importance.

## PLUGGED CRACKED CONDENSER TUBE SHEET

The accompanying sketch shows how repairs to a cracked tube sheet of a surface condenser were made. The tubes following the crack were removed and the ferrules used as plugs, first filling them with lead.




CRACK IN CONDENSER HEAD MADE TIGHT WITH PLUGS

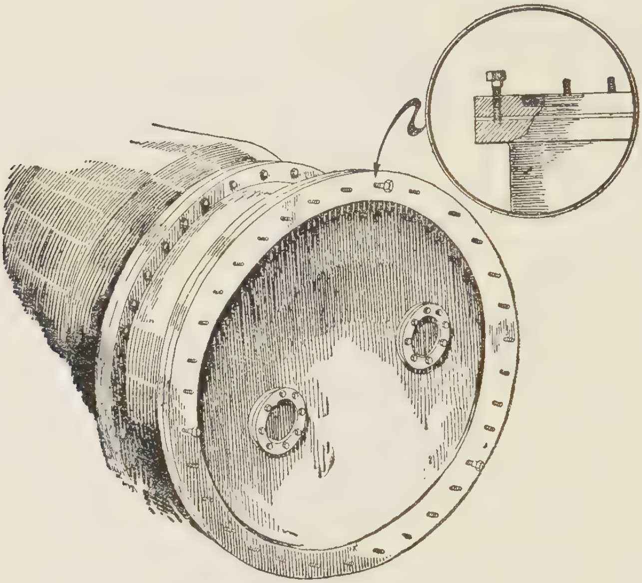
After screwing them in solid, holes were drilled and tapped into the crack between the plugs for $^5/_{16}$-in. plugs, which filled up the space between the ferrule holes. Dressing with a calking tool completed the job.

## REMOVING HEADS FROM SMALL CONDENSERS

Several small surface condensers had to be cleaned out frequently, owing to the dirty circulating water used. When it came to take off the condenser heads, it was frequently found that the packing had cemented the two surfaces together so that it was necessary to drive in a cold chisel to pry the two sections apart. This operation usually meant that a new gasket had to be cut.

In order to avoid this expense and inconvenience the following plan was worked out: On opposite sides of the condenser-head plate holes were drilled and threaded for ¾-in. bolts. Into these holes were screwed round-ended ¾-in. bolts, as shown. Then the head was drawn off, merely by pulling up on the bolts, which pressed against the flange

of the condenser and pushed the head plate away from the condenser body without difficulty.



USING BOLTS FOR REMOVING CONDENSER HEAD

## RIG FOR REMOVING A CONDENSER PLATE

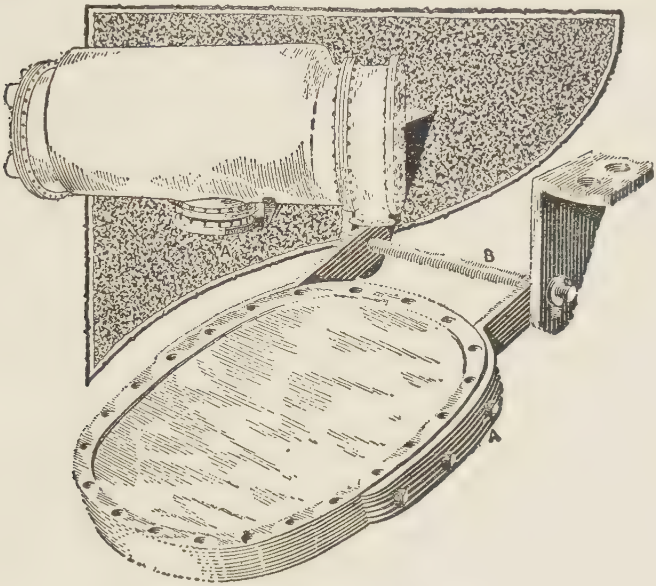
In a certain plant the surface condenser is fitted with a heavy removable cover plate at the bottom of the shell. Originally, the plate was held in place by studbolts, and when it was necessary to remove it the services of two men were required, one to hold the plate in position while the last two nuts were removed.

In order to make removal easier and also to reduce the number of men required to do the job, two $\frac{1}{4}$ x $\frac{1}{2}$-in. iron straps *A*, to act as hinges, were bolted to the cover plate as shown on page 182. The other end of each was drilled for a $\frac{1}{2}$-in. rod *B*.

Bolted to the body of the condenser shell is a pair of angle irons spaced 8 in. on the inside. Each is made with an oblong hole, the object being to allow the plate to drop at the hinge end sufficiently to permit the plate to take a level position before the stud enters or leaves the holes in the plate. It is readily seen that with the aid of the hinges one man can easily remove and replace the plate, which hangs from the condenser while work is being done and is therefore ready to be replaced when desired.

## RUBBER SLUGS FOR CLEANING CONDENSER TUBES

It does not take long for condenser tubes to become so heavily coated




HINGED CONDENSER PLATE

For text to this illustration see page 179.

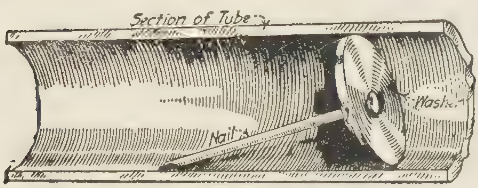



Fig. 1

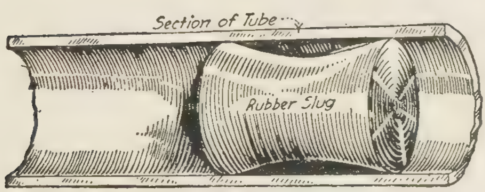



Fig. 2

WASHER AND SLUG FOR CLEANING SLIME FROM CONDENSER TUBES

with scum that the heat transmission through them decreases sufficiently to seriously impair the vacuum.

For tubes that scale the most satisfactory practice seems to be the use of a mechanical cleaner similar to those used in cleaning boiler tubes.

But for freeing tubes of the scum that collects in them many devices are in use. One that is quite widely applied consists of a leather or rubber washer of diameter to fit the tube and through the center of which a nail is driven, Fig. 1. Many of these are made and one placed in each tube when about to clean the condenser. The nail holds the washer almost on edge. Compressed air is used to force the washer through the tube.

If the washer does not make contact all around the surface of the tube it does not thoroughly clean off the scum, therefore rubber slugs of the shape shown in Fig. 2 can be used. These are placed, one in each tube, and blown through by means of compressed air. The results are highly satisfactory. The slugs are of rubber that is neither very hard nor very soft.

## SAFETY DEVICE FOR HYDRAULICALLY OPERATED RELIEF VALVE

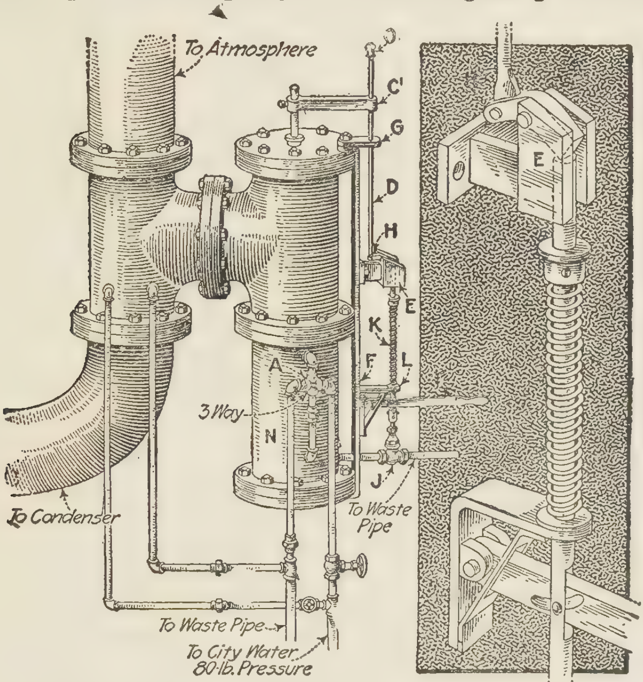
When the relief pipe of a turbine or engine installation exhausting into a surface condenser is fitted with a hydraulically operated atmospheric relief valve, there is a possibility of the operator leaving the water pressure on the piston of the hydraulic cylinder after closing the valve, when it should be shut off, thus permitting excessive pressure to build up in the condenser in case the vacuum is lost and the units attempt to operate noncondensing.

A simple but effective device has been designed in one instance to prevent such an occurrence: The 8-in. water piston that actuates the relief valve is controlled by a three-way valve *A* and is connected to the water-supply pipe and to a waste pipe, as shown. In case the operator admits city water (which is at 80 lb. pressure in this instance) in order to close the atmospheric valve, and for any reason should neglect to shut off the water pressure, a water-relief valve will automatically operate and relieve the pressure from the operating piston and thus permit the main relief valve to open before pressure is built up in the condenser.

The way this is done is as follows: The top cylinder head is drilled for the extension of the piston rod, and to this is attached an arm bent at right angles and having a hole at the outer flattened end *C*, which slides on a 3/8-in. rod *D*. At the top of the rod *D* is a stop O and the other end of the rod is flattened and drilled with several adjusting holes so that the proper adjustment may readily be obtained for opening the water-relief valve *J*.

A bracket *E* is secured to a base that is bolted to a 3/8-in. thick supporting iron *F*, which in turn is secured to the hydraulic cylinder as shown, the upper bolt also serving to hold the guide *G*. The bracket *E*

is slotted at the top, in which is fitted a trigger *H*, one end of which is pinned to hold the rod *D* and the other end rests on the extension end of the valve stem of the water-relief valve *J*. The valve-stem extension is fitted with collars between which is a spring *K* that is under tension when the trigger *H* is in place. The bottom end of the extension rod is guided by an angle iron *L*, and just below the angle iron is a washer to prevent the spring *K* from having too great a movement.




DETAILS AND APPLICATION OF THE RELIEF VALVE

One end of the lever *M* is pivoted to the bracket that is fastened to the cylinder *N*, and is attached to the valve stem by a pin that works in the slightly curved slot in the lever, which provides free movement as the valve stem moves up and down.

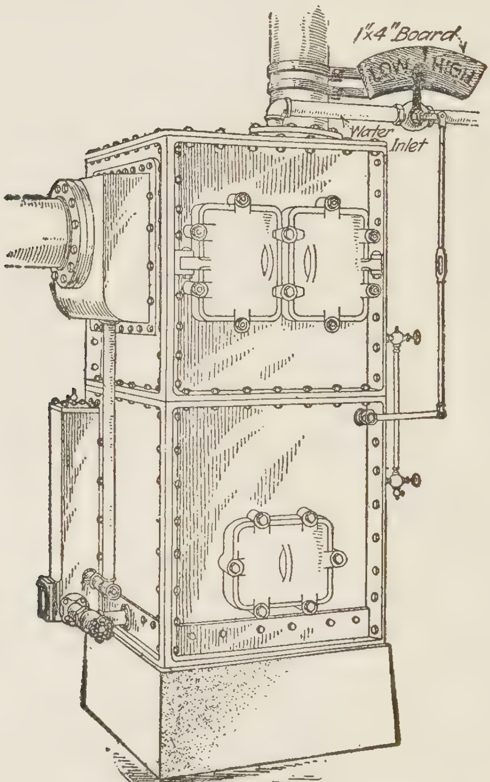
The operation of the device is as follows: In case the operator is suddenly called away after having opened the three-way valve, the water pressure of 80 lb. will force the piston in the water cylinder *N* up until the arm *C* engages with the knob *O*. Any further upward movement of the arm *C* disengages the latch *H* and allows the spring *K* to open the relief valve *J*, thus allowing the water pressure in the cylinder *N* to escape. This permits the relief valve to open without building up excessive pressure in the condenser.

## *SECTION X*

# GAGE KINKS

### HEATER WATER-LEVEL INDICATOR

WATER enters at the top of an open heater through a quarter-turn



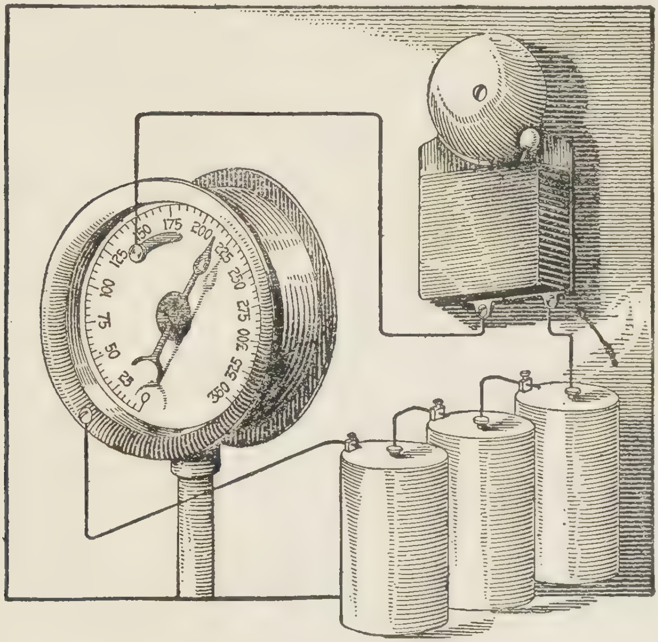

HIGH- AND LOW-WATER INDICATOR

valve operated by a lever and a rod connected to a float in the heater. As the glass gage was at the bottom, it could not be readily seen.

An indicator was made from a piece of iron about 1½ in. wide by 12 in. long, cutting a square hole in one end of the valve stem at the top of heater and shaping the other end as shown. This pointer was placed on the valve stem so that when the water was at the proper level it would stand plumb. A board was also made fast to the heater and marked where the pointer should be. This pointer is moved back and forth by the float as the water level in the heater changes. If the heater becomes dry, or nearly so, the pointer will indicate it by pointing to one side, marked "Low" on the board, and when the water gets high it will point to the high side.

## HYDRAULIC PRESSURE-GAGE ALARM

A pressure alarm attached to a hydraulic gage in a certain plant was made by drilling a small hole in the glass face of the gage in line



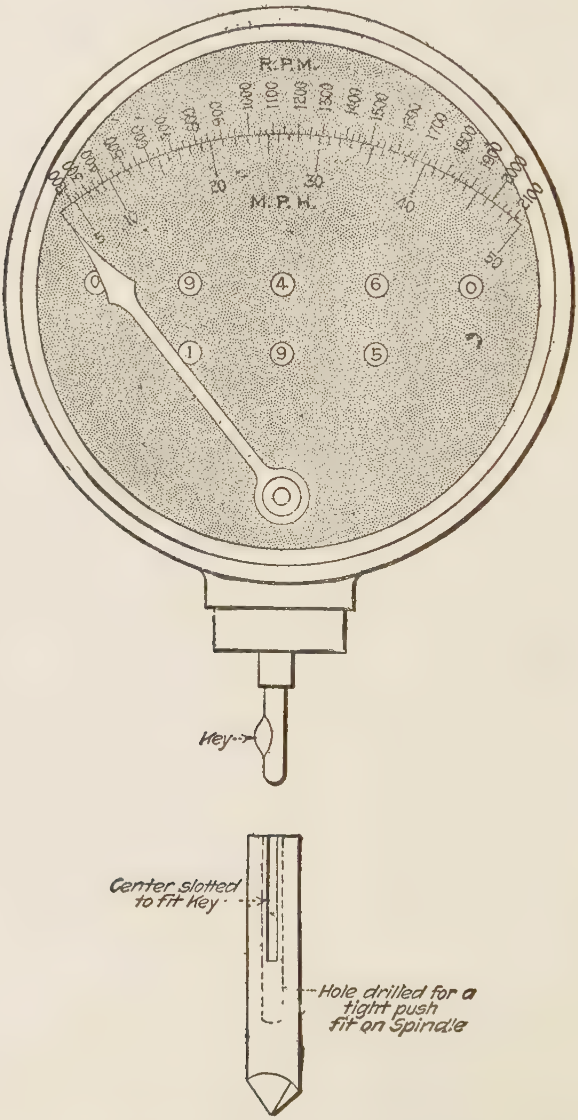
ARRANGEMENT OF CONTACTS ON PRESSURE GAGE

with the travel of the pointer, through which an electric terminal was attached, as shown in the illustration. The other terminal was connected to the body of the gage. The bell can be set to ring at any pressure by adjusting the glass face of the gage. In this plant it is set at 175

lb. When the pressure drops to this point, the pointer completes the circuit and the bell rings, giving the alarm to the engineers in charge, who get into quick action to find the cause of the low pressure.

## A HOME-MADE TACHOMETER

A hand tachometer can be made from an old automobile speed indi-




GRADUATIONS ON TACHOMETER DIAL

cator that is in good condition and make a temporary handle to go on the spindle, so as to turn it and count the revolutions. Then count the number of revolutions the spindle would have to make per mile of the recording dial, which is, say, 2560.

The next thing is to find how many revolutions per minute were equal to one mile per hour: $2560 \div 60 = 42^2/_3$ r.p.m. = 1 mile per hour. Then paste a piece of tracing cloth over the old dial and work out the points on the scale corresponding to 200 r.p.m., 300 r.p.m., etc., up to 2100 (the limit in this case is 50 miles per hour or $2133^1/_3$ r.p.m.) thus: 200 r.p.m. $= \frac{200}{42^2/_3} = 4.72$ miles per hour; 300 r.p.m. $= \frac{300}{42^2/_3} = 7.08$ miles per hour, etc.

Then mark these points on the tracing cloth corresponding to the miles per hour and mark the r.p.m. opposite, and after the whole scale is worked out, sub-divide these divisions into smaller divisions equal to 25 r.p.m., thus completing the scale.

A piece of round steel is drilled the exact size of the spindle, and a slot made in it to fit the key on the spindle. Having got this fitted, file up a diamond-point center and harden it. This completes a handy speed indicator, which is accurate enough for most purposes.

## OIL INDICATOR GAGE

A firm recently installed oil-burning equipment for their boilers. They desired a gage to show the quantity of oil in the tank, which is below the ground, and for this purpose adapted a water-level indicating gage similar to those used for showing the elevation of water in reservoirs, etc.

The gage has a 5-in. dial furnished in black with white enamelled figures and letters and sets on a 5-in. wrought-iron pipe which contains a float resting on the surface of the oil in the tank below. The small pipe at the right guides the counterweight. The dial may be graduated directly in barrels, gallons, or pounds; in the instrument illustrated each division represents 50 gallons. The amount of oil put into or taken out of the tank is readily determined by observing the amount of movement of the dial hand which also shows the amount of oil in the tank.

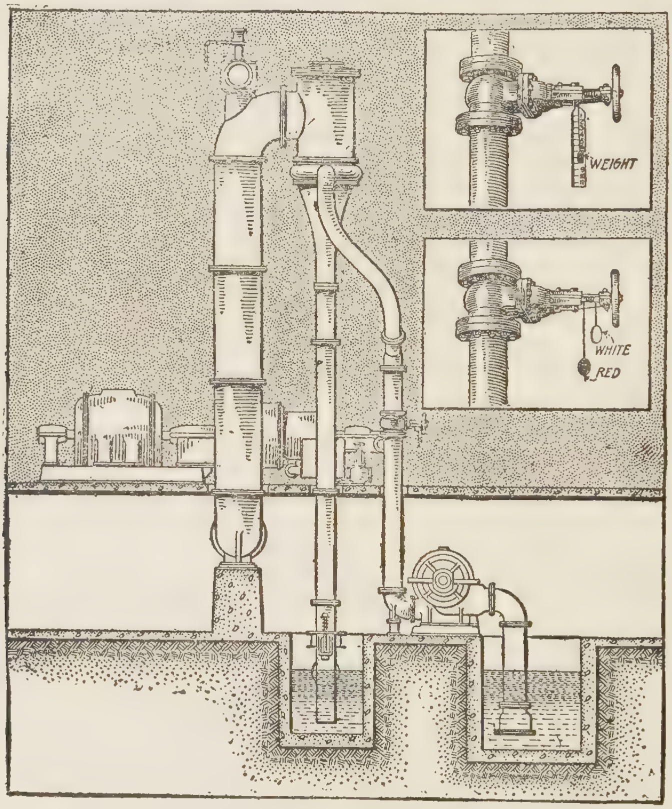
The measurement of fuel oil in power plants with the usual types of meters presents certain difficulties which often make its measurement impracticable. The method described herein obviously has great advantages over the old method of measuring black, sticky oil with a measuring rod.

If the float pipe cannot be placed directly over the tank it may be possible to connect the two at the bottom by a small pipe and thus the gage can be located at considerable distance away. If it is not possible to change the location of the float pipe the gage may be located at some distance from it by leading the float cord over special idler pulleys.

## INDICATOR ON INJECTION-WATER VALVE

The following idea was adopted to show at all times the amount of valve opening on the injection line of a jet condenser, and it can readily be used in other instances.

The large illustration and top insert show the idea, which consists




INDICATORS FOR VALVE STEMS

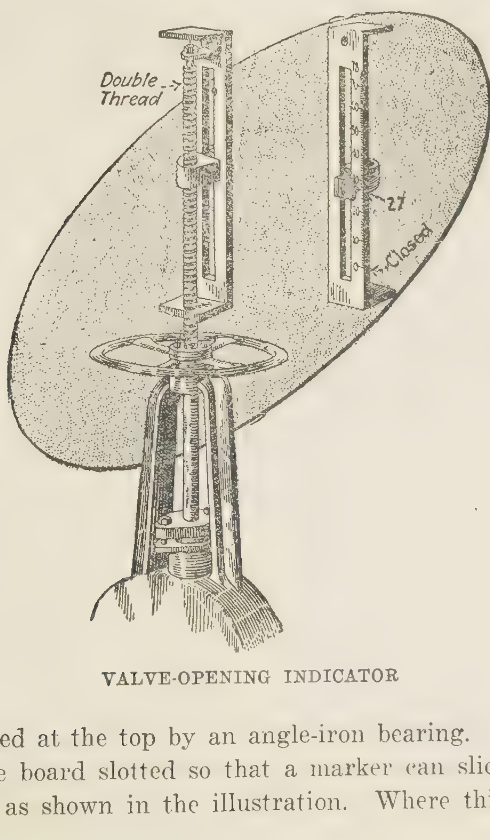
simply of a cord, one end of which is attached to a weight, the other end being secured to the valve stem by means of a pin. A card, grad-

uated by trial, is affixed alongside of the weight, and the position of this weight corresponding to the valve opening will at all times be indicated.

A modification of this scheme, to serve as a warning sign as to whether or not the valve is opened, is illustrated in the lower insert. In this case a red disk is attached to the weight and its position hanging below the valve wheel will indicate danger. Another weight, with a white disk, is attached to a cord and secured to the stem so that it will be wound up while the red disk is down and vice versa. This will indicate valve open or valve closed. The disks can be changed to indicate in the opposite manner, if preferred.

## INJECTION-WATER-VALVE GAGE

The accompanying illustration shows a rig for gaging the amount the injection valve is open. Attached to the top of the valve handwheel is a flange in which is screwed a double-threaded stem and



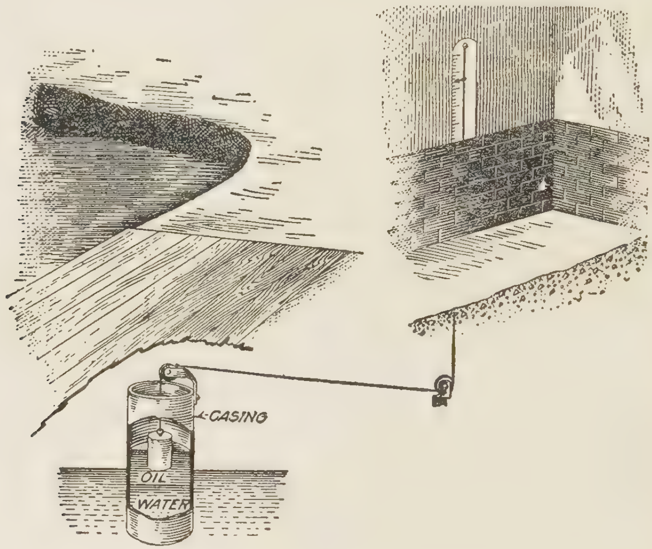

VALVE-OPENING INDICATOR

which is steadied at the top by an angle-iron bearing. In front of the screw is a gage board slotted so that a marker can slide from the top to the bottom, as shown in the illustration. Where this rig was used,

it required 78 turns of the handwheel to open the valve wide. The running position at the time the sketch was made was 28 turns. The general arrangement is shown, and the gage board can be secured either to the valve proper or to an overhead source. The value of the arrangement is obvious.

## PREVENTING TELLTALE FLOAT FROM FREEZING

A simple kink used to keep a headwater float gage from freezing and becoming inactive in a hydro-electric plant is illustrated herewith. Hourly records are kept of the height of the headwater in the flume,



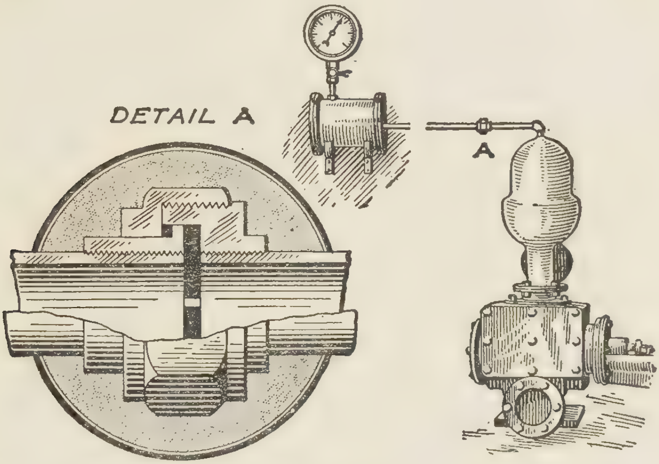

NON-FREEZING TELLTALE FLOAT

and to do so a closed metal float is placed in a vertical piece of 6-in. pipe which is hung in the flume. A line from the float runs over the guide pulleys and connects to a marker that slides up and down on a graduated board attached to the side wall of the generator room, thus at all times indicating the height of the water.

To keep the float from freezing fast in the winter, put about two gallons of kerosene oil in the pipe and then recalibrate the gage, which works to perfection.

## PULSATION OF PRESSURE GAGE STOPPED

The illustration shows the means employed to prevent the pulsating action of a pump being transmitted to the pressure gage. It is the general practice to partly close the stop-cock under the gage in such cases, but the extremely small opening is in danger of being closed by a small particle of scale or other foreign substance. By using a chamber beyond the restricted opening the desired dampening effect is obtained with a large opening, less likely to choke up. The reservoir




PRESSURE GAGE ON AUXILIARY AIR CHAMBER

should hold about three gallons and when attached to an 18 x 10 x 18 pump, with an opening $^3/_{32}$ in. in diameter in the diaphragm, clamped in the union, it allows the gage to stand "dead steady."

## RUNNING STEAM ENGINES WITH COMPRESSED AIR

It is sometimes possible or desirable to operate steam engines with compressed air in the event that no steam is available and compressed-air service is to be had.

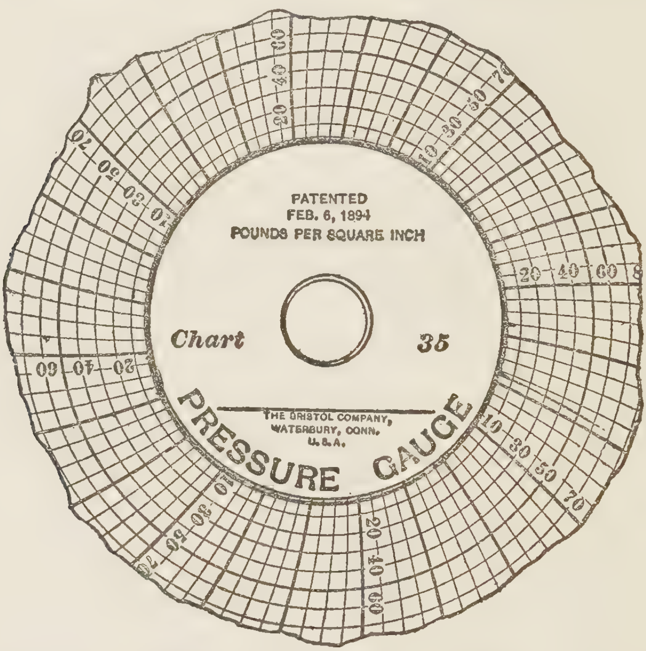
Small and medium-sized steam engines will operate very well and can be used for an indefinite time on compressed air if the pressure is suitable. Ordinarily, there need be no change in the setting of the engine valves. Simply connect the air service to the steam pipe of the engine and use air instead of steam. It is often desirable to disconnect the exhaust system of the engine so that it can exhaust directly into the atmosphere, thus eliminating back pressure.

In expanding in the engine, the air takes heat from the cylinder

walls, thus cooling these parts to a considerable degree below the temperature of the atmosphere. While a certain amount of water is usually carried into the cylinder with the air and will assist in lubrication, it is well to arrange for more certain cylinder lubrication than this. Thick cylinder oils such as employed for steam service should not be used, for they are intended for use in a heat which will thin them somewhat and if used with air the cold will render them less fluid. Practical experience has shown that common machine oil such as used for bearing lubrication gives satisfaction.

## RECORDING GAGE ON POP VALVE

In order to prevent the loss from needless blowing of the pop valves on boilers, a recording pressure gage was connected to the discharge



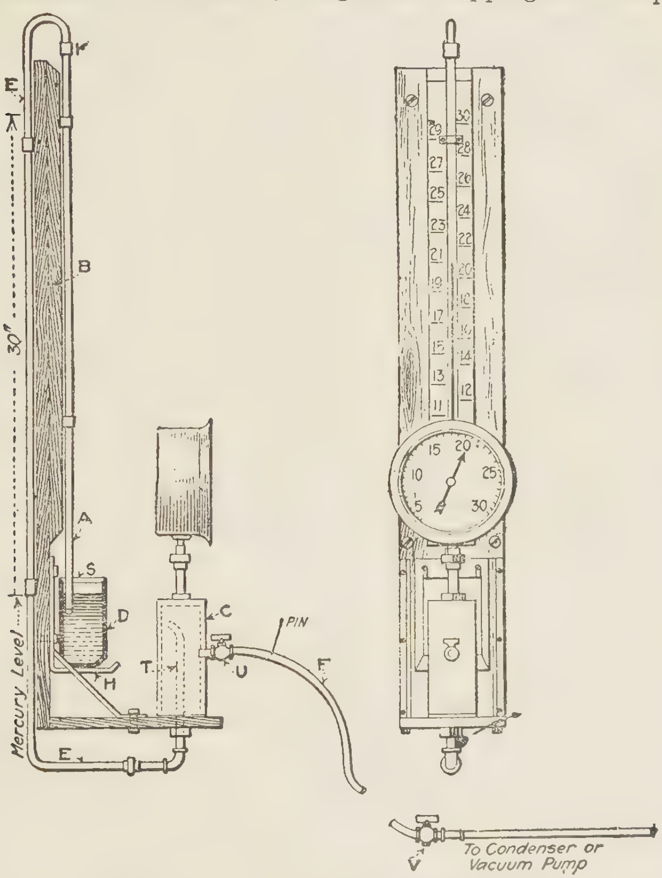

RECORD SHOWS WHEN POP BLOWS

of the pop valve. The chart in the illustration shows that the valve opened only once in twenty-four hours.

## VACUUM-GAGE TEST COLUMN

The illustration shows a vacuum-gage test board, an instrument seldom found in a power plant. This device can be made from material found about the plant. A description of the test board follows:

A mercury-column glass tube $A$, $^5/_{16}$-in. outside diameter, having a $^1/_{16}$-in. hole, and 34 in. long, is secured to the board $B$, as shown. To the shelf of the board is attached a short piece of 2-in. pipe $C$, plugged at both ends, the top end being tapped for a $3/8$-in. pipe and the bottom end for a $1/8$-in. pipe. In this piece of pipe is a bent tube $T$. It is bent for two reasons—to prevent anything from dropping into the pipe and




APPARATUS FOR TESTING VACUUM GAGE

so that in case of accident if mercury is drawn over from the mercury gage, it will collect in the reservoir.

Attached to the gage board is a bracket $H$, having oblong bolt holes so that it can be adjusted up or down to get the mercury level, the mercury being contained in a common drinking glass $D$ covered with a cork or wooden covers. A pipe or rubber hose $E$ is connected to the top of the mercury column and to the bottom of the cylinder $C$. If a pipe is used, it is connected to the glass tube by a rubber nipple $K$. Of

course there must be a vacuum pump or condenser in the plant; if not, a vacuum gage is not needed. A test pump is eliminated, and so there is nothing to get out of order.

To operate, attach the vacuum gage to be tested as shown and open the cock *V*. Then very slowly open the cock *U* just enough to start the mercury up into column *A*. When the mercury is at its height limit, shut the cock *V*, and if everything is tight the mercury will be at a standstill. Then connect the gage with the mercury column. For testing at various points, lower the mercury to any graduation and make a pinhole in the connecting hose near the cock *U*, and when the mercury drops to the point desired put a finger over the pinhole. In this way one can test a gage with a mercury column all the way down from zero to the limit of the gage. If there is a slight leak in the connection and the mercury will not stay up with the cock shut, open it just enough to balance the mercury.

# *SECTION XI*

# COMPRESSOR KINKS

## AIR-COMPRESSOR EFFICIENCY IMPROVED

It was discovered that the intake pipe of an air compressor had parted sufficiently to permit the entire air supply to be taken from a point indoors, below the cylinder. A thermometer placed at the break showed a temperature of 100 deg. F., while the temperature out of doors was 47. Since the loss in efficiency equals about 1 per cent for each 5 deg. rise in temperature of the air supply, it will be seen that the loss in this case was over 10 per cent.

This compressor carried a constant load, a smaller one taking care of variations, and after repairing the break an appreciable difference could be noticed in the load carried by the smaller machine.

## CARE OF AIR VALVES

In the care of air valves it is good practice to inspect and clean off the accumulated carbon at regular intervals. Carbon may cause leakage, and leakage certainly causes carbon. A leaking valve becomes hot from the passage of the heated air back through it, and this heat forms carbon from the lubricating oil. This carbon in turn may make worse leakage and worse heat, resulting in an overheated and warped valve, which becomes worse with continued use.

Valve trouble may be located in several ways. In a compound compressor, if any of the low-pressure valves are out of order, the intercooler pressure will be below normal because the low-pressure cylinder will not be furnishing enough air to keep the intercooler pressure up to what it should be. Trouble with valves in the high-pressure cylinder will be indicated by a rise in intercooler pressure above normal. This is because the high-pressure cylinder will not be taking the air away from the intercooler fast enough to prevent the abnormal building up of the pressure.

The statements as to the effect of the valves upon intercooler pressure apply equally well to inlet or discharge valves. Any particular defective valve may be located by its being hotter than the others. This is especially true of the intake valves.

One of the most important items in running an air compressor is lubrication. In modern machines the running parts are usually inclosed in a crankcase and run in oil. The oil is made to circulate from the bottom of the bed over all the bearings, pins and guides and then runs back into the bottom of the bed again.

The air cylinders are sometimes lubricated by a sight-feed oiler so designed that the pulsation of the air pressure assists the feed of the oil. Also, sometimes the air cylinders are lubricated with a positively driven oil pump.

Two principles should be maintained in lubricating an air cylinder. The first is to use only the right kind of oil and the second is to use it sparingly. To be the right kind, air oil should be rather light-bodied and have a flash point above 300 deg. F. It should not carbonize under air-cylinder temperatures. These temperatures range around 260 deg. F. for compound compression to 100 lb. pressure and 360 to 375 deg. F. for single-stage to the same pressure.

Probably the best way to secure the right oil for air cylinders is to buy oil specially made and recommended by only first-class and highly reputable oil concerns. At any rate a short trial of a sample will soon demonstrate the quality of an oil for air-compressor service.

As to the second principle—to use the air cylinder oil sparingly—after a machine has been well run in three or four drops per minute are enough for a good-sized cylinder. If too much oil is used it will result in excessive carbonization. Another evidence of too much oil is to see coating the outsides of the cylinders and piping, having worked its way through the joints. This is bad practice.

One important point is to see that the air receiver has all the accumulated oil drained out of it every little while. If too much oil is used or the receiver is not properly drained, gases may be formed which may ignite spontaneously and cause a bad explosion. This is a point that should be scrupulously observed in order to secure safety as well as continuity of service.

It is often recommended that a solution of soft soap or laundry soap and water be fed to the cylinder at stated intervals to clean out carbon deposit. This solution may be fed through the regular air-cylinder lubricating devices. Of course, after this treatment the interior of the cylinder may rust quickly unless the soap solution is followed up with oil for some time before shutting down. Never, under any circumstances,

should kerosene or gasoline be used to clean out an air-compressing cylinder. Its use may easily lead to a disastrous explosion.

## NOISY COMPRESSOR VALVES

Slamming air-valves gave trouble in a compressor delivering air at 15 lb. pressure. The seat was made at an angle of 45 deg. and was 3½ in. diameter. The outside diameter of the valve was 4 in., with 1-in. lift, and it was held to the seat by a spring made of steel 0.145 in. in diameter and 11 in. long, with 20 coils. It requires 18 lb. to compress it 6¼ in., the closed position of the valve.

Originally, the seats came flush with the surface of the valve deck, but repeated grinding and reseating had brought them about ⅜ in. below the surface, as shown in Fig. 1. Someone had bored the deck

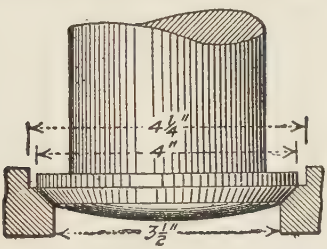



FIG. 1. LOW VALVE SEAT FROM REGRINDING

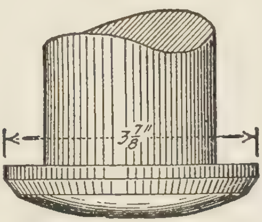



FIG. 2. NEW DIAMETER OF THE VALVE

surrounding the seat to a diameter of 4¼ in. to provide space for the escape of the air, but it was not enough.

The inside diameter of the contact circle between the valve and the seat was 3½ in. and the outside diameter was 4 in., a difference in area of almost 3 square inches. With 15 lb. pressure per square inch in the cylinder and the same pressure on the discharge side of the valve, there would be an unbalanced pressure of a little more than 44 lb. plus the pressure of the spring, 18 lb., and a little due to the oil film on the seat.

To balance this, the pressure in the cylinder had to rise to about 21.5 lb. per sq.in. As soon as the valve lifted from the seat, on account of the restricted passage for the escape of the air this pressure would be exerted on the 4-in. diameter of the valve with the result that the valve would be thrown back against the stop, causing a slam, and when seating the heavy spring would cause a second slam.

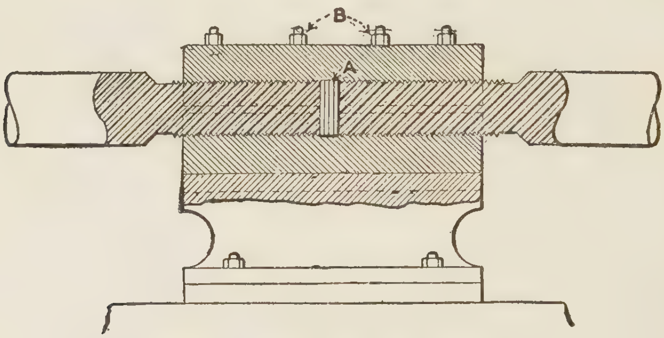
To overcome the first slam a part of the valve face was turned at and the outside diameter of the valve turned down from 4 to 3⅞ in., an angle of 55 deg., leaving an annular contact circle about ⅛ in. wide, giving more opening for the escape of the air (see Fig. 2). In order

to relieve the second slam the springs were changed to weaker ones, making them 9 in. long with 18 coils, 0.125 in. steel, $2\frac{1}{8}$ in. outside diameter, and requiring 6 lb. to compress to $6\frac{1}{4}$ inches.

## PISTON-ROD ENDS WORKED LOOSE

The piston rods in a large double-acting tandem gas engine kept working loose in the intermediate crosshead. No matter how tightly the cap was pulled down, the rear rod would work loose and turn far enough to one side to let the tail-rod drain pipe rub the side of the slot in which it worked, to say nothing of spoiling the threads on the rod ends and in the crosshead. The construction of the crosshead was as shown in the cross section of the rod ends and the crosshead.

The usual practice in putting up this crosshead had been to raise the rod ends as high as possible, put the bottom half of the crosshead




SECTION THROUGH CROSSHEAD

under, insert enough sheet-iron shims *A* between the rod ends to hold them in the proper position so that the threads in the bottom half of the crosshead would incline to pull the rod ends together when they were let down into place. The top half of the crosshead was then put on and pulled down as tight as possible with the nuts and studs *B*.

It was noticed while taking down the crosshead that the sheet-iron shims would be beaten out flat and although there had been as many put in as possible, they were loose when taken out. From this it was reasoned that there was too much give or spring to these shims and that as soon as the strain came on they flattened out and compressed together enough to allow the rods to come loose again.

The trouble was remedied by making cast-iron shims of the proper thickness to hold the rod ends just far enough apart that the back half

of the thread on the rod would ride hard on the front half of the thread in the crosshead; the cap when put on was pulled down as tight as possible.

## POSITION OF AIR RECEIVER

The air receiver should be as near the compressor as practicable, and there should be a separate pipe from each compressor to the receiver. The practice of connecting a battery of compressors to a long header pipe leading to a receiver outside the building is not good. Under certain conditions this produces pressure surges in the air moving down the long pipe, which materially increases the power required to drive the compressor. These surges require energy to produce and, as they serve no useful purpose, are a direct waste of power. It is better to have a receiver for at least every two compressors and each machine connected through a separate pipe of its own, the piping to the receiver being as short as possible and the full size of the compressor outlet.

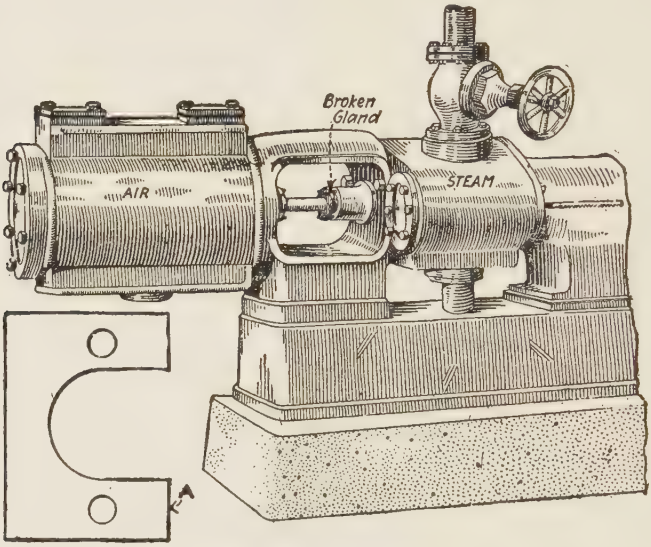
There is no established rule for the size of the receiver. If the character of the work is intermittent a more generous receiver capacity is advisable. However, it is possible in most cases to store only a relatively small amount of air in a receiver with permissible pressure fluctuation. A rough rule is to provide a storage of approximately one minute's supply of air. Thus for the 2800-cu.ft. compressor we would have approximately 466 cu.ft. of compressed air per minute, so a cubic content of 400 cu.ft. would be liberal receiver capacity. This would be about 66 in. in diameter by 18 ft. long. The pipe leading the air from the compressor should enter the receiver near the top and leave near the bottom to assist separation of moisture and oil.

## PREVENTED STEAM IN COMPRESSOR WATER JACKET

A well-known type of cross-compound air compressor was sent out from the factory with a ¼-in. pet-cock screwed into the highest part of the water jacket on the low-pressure cylinder for releasing the steam that might accumulate at this point. It was found that in practice this cock was seldom opened, and to obviate this non-automatic feature, it was removed and enough ¼-in. pipe and fittings used to run this discharge to the funnel that catches the cooling water coming from the cylinder. A small part of the cooling water is discharged from this pipe and thus prevents any accumulation of steam.

## REINFORCING A BROKEN STUFFING BOX GLAND

The sketch shows the steam and air cylinders of an air compressor, the stuffing-box gland of which broke on the steam end, as indicated. An emergency repair job consisted of placing a piece of iron plate *A*




BROKEN GLAND AND REINFORCING PLATE

over the broken gland. Of course longer studs had to be made, but the makeshift worked all right in keeping the gland in place.

## TEMPERATURE OF JACKET WATER

For the jackets of a compound unit the total water required for the two cylinders need not usually exceed 1 to 1½ gal. per 100 cu.ft. of free air. Thus, with reasonably cold water (60 or 70 deg. F.) the 2800 cu.ft. compound compressor could get along nicely on 35 gal. per min. for the two cylinder jackets alone. For the intercooler of a high-grade compound, 100-lb. unit, it is usually safe to figure on from 2½ to 3 gal. per 100 cu.ft. of actual free air. On this basis the intercooler of the 2800-ft. unit would require from 70 to 85 gal. per min., if the intercooler were of efficient design.

For most compressors a water pressure approximating 20 lb. per sq.in. is usually sufficient, and if possible it is best to have the outflow water piping discharge into an open funnel. By this means both the quantity and temperature may easily be observed. It is best to adjust

jacket water so that as it leaves it just begins to feel warm to the hand. Any more than this is really a waste of water and any less may quickly become hot and cause excess cylinder heating and oil carbonization.

Water for intercoolers and aftercoolers is best regulated by a thermometer in the *air* leaving the cooler. There is a point beyond which an enormous increase in water quantity will not produce appreciably better intercooling. Of course all water jackets should be so piped that they may be completely drained to insure against freezing in case the engine room should become cold. All first-class compressors are designed to provide for this, but the water piping should be arranged to accommodate this condition also. This also applies with equal force to intercoolers and aftercoolers.

It is a good thing to clean out the sediment and scale which may accumulate in the jackets. Large machines often have handholes in the outer jackets to assist in this cleaning, and the occasional application of scrapers and a waterhose will help on all sizes. Intercooler and aftercooler tubes need this attention occasionally. Most coolers are made so ‘ the tube nest may be removed for inspection, repairs and cleaning.

# SECTION XII

# HEATING KINKS

## ABSTRACTING HEAT FROM BLOWOFF TANKS

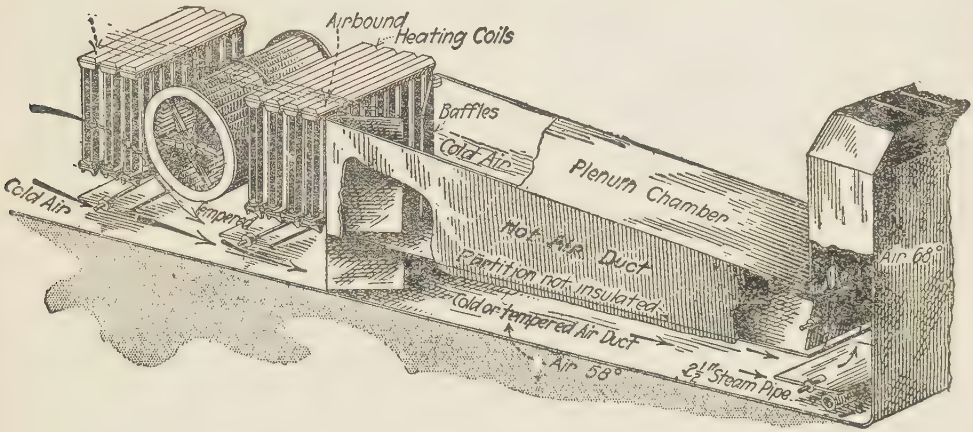
Drip and blowoff tanks containing hot water that cannot be utilized should be equipped with inside coils of pipe through which water on its way to the house hot-water tanks and feed pumps can flow, thus absorbing the heat from these dirty drips and blowoffs, which would otherwise go to the sewer.

## EXPERIENCE WITH AUTOMATIC INDIRECT HEATING SYSTEM

An automatically controlled indirect heating system would not heat the whole building at once. One half would not heat until the other half was up to temperature and the thermostats had closed half the dampers in the plenum chamber. It was found that, on very cold days especially, the heating coils would heat only halfway across. Raising the pressure to 15 or 20 lb. did no good. The steam supply was of ample capacity and the manifolds, top and bottom, were large, but the air vents or valves were located on the wrong side of the radiators, allowing them to become airbound, and of course the air passing at that side was not heated. It was impossible to change the location of the valves during the heating season, but the operation improved by installing baffles in the plenum and tempered-air chambers in such a way as to mix the air to a uniform temperature, after which there was no trouble in raising the temperature evenly throughout the building.

In mild weather the building was overheated because the thermostat in the tempered-air chamber was located about midway of the length of the tempered-air duct instead of at the extreme end, therefore the thermostat was set for a low temperature (58 deg.) at this point because the temperature was increased another 10 deg. in passing to the end of the duct, partly because of the partition between the two chambers, the

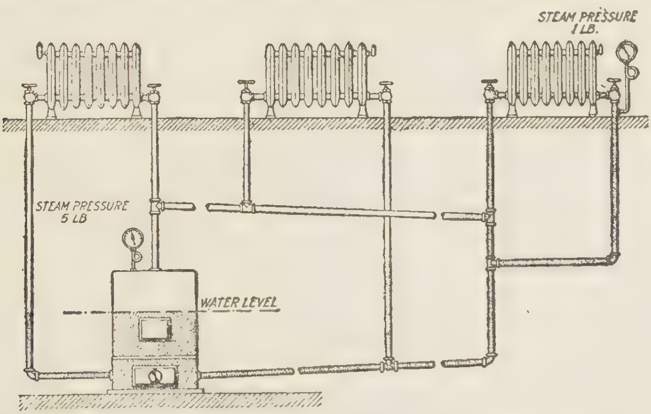
tempered-air and hot-air duct not being insulated. An uncovered 2½-in. live steam pipe in the tempered-air duct also tended to raise the temperature still more.




GENERAL ARRANGEMENT OF COILS, FAN AND DUCTS

## FAULTY DESIGN IN HEATING SYSTEMS

One of the most common mistakes made in installing heating boilers is that the distance vertically that should be allowed between the water



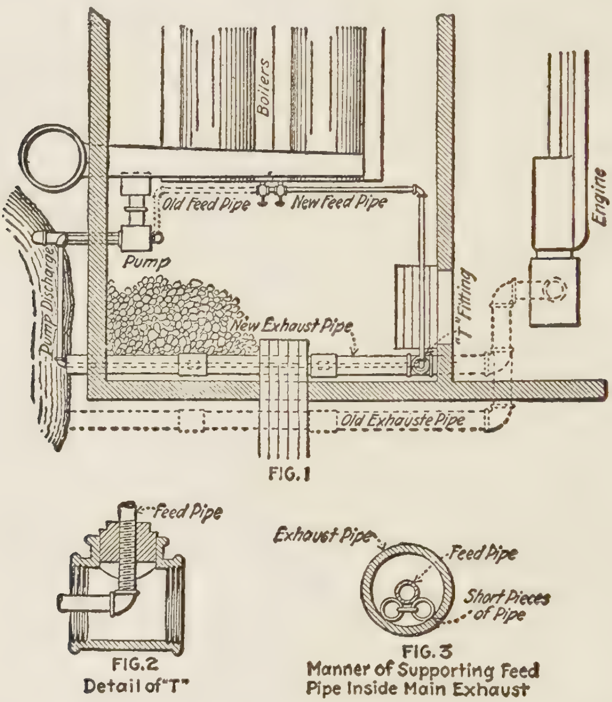

PRESSURE DROP IN LINE FLOODED RADIATORS

line in the boiler and the lowest point in the horizontal steam supply above the boiler is not carefully considered. The loss of pressure in the supply pipes between the boiler and the extreme end of the return pipes will allow the water to rise until a column equal in weight to the difference in pressure has accumulated in the system. The water some-

times reaches the main steam pipe and first-floor radiation, as shown in the illustration. Equalizer connections at the boiler will not remedy this mistake.

## IMPROVISED FEED-WATER HEATER

The illustration shows the general arrangement and details of a feed-water heater. Originally the 6-in. exhaust pipe from the engine passed out through the wall and horizontally, as shown in dotted lines,




FIGS. 1 TO 3. BOILER FEED PIPE PLACED INSIDE ENGINE EXHAUST
Fig. 1. General layout of the plant. Fig. 2. Detail of feed pipe through a tee. Fig. 3. Support of feed pipe inside the exhaust pipe.

to the bank of the creek on which the plant is situated. The pump drew water from the creek and in the first arrangement pumped the feed water directly into the boilers through a 1½-in. pipe, also shown dotted.

The exhaust pipe was shifted to the inside of the boiler room, with a 6 x 6 x 4-in. tee near the wall between the engine and boiler rooms, as shown by the full lines. The discharge pipe from the pump was

changed to the opposite side of the valve chamber, run out through the wall and then turned back, so as to enter the open end of the exhaust pipe, and it runs inside this to the tee fitting, where it passes out and is connected to the old boiler-feed line. The details of the tee fitting are shown.

The feed pipe is supported inside of the exhaust line near the couplings by a couple of short lengths of $1\frac{1}{2}$-in. pipe wired together so that the exhaust will pass through freely. The heater is not very efficient, as it has so little heating surface, but it will help some if no better arrangement can be made.

## INSTANTANEOUS WATER HEATER

A simple method of heating water is shown in Fig. 1. It obviates annoying water-hammer and spasmodic flow, which is associated with

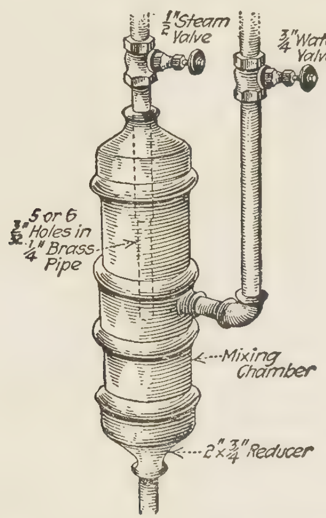



FIG. 1. STEAM WATER-HEATER

most direct-connected pipe arrangements. The mixing chamber prevents water-hammer and permits a wide range in temperature. The heater, or mixing chamber, can be made of any convenient fittings, bushings and couplings, tapped caps or reducers, but the latter make a better-looking job. The illustration shows how this heater is made and that it is in a vertical position, but there is no reason why it will not work in a horizontal position as well.

In another case it was desirable to get hot water of uniform temperature by mixing steam and cold water and an arrangement as shown in Fig. 2, was designed, consisting of two globe valves and a small coil

made up of short pieces of pipe joined with return bends to produce a thorough mixing effect. The globe valves were throttled down to pass just the right amount of water and steam, and the handwheels were then taken

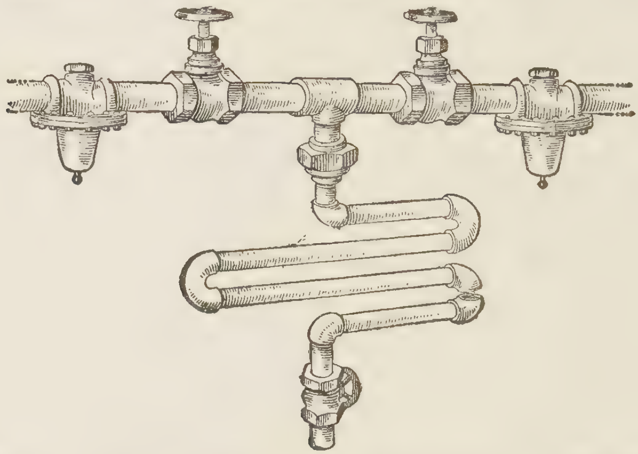
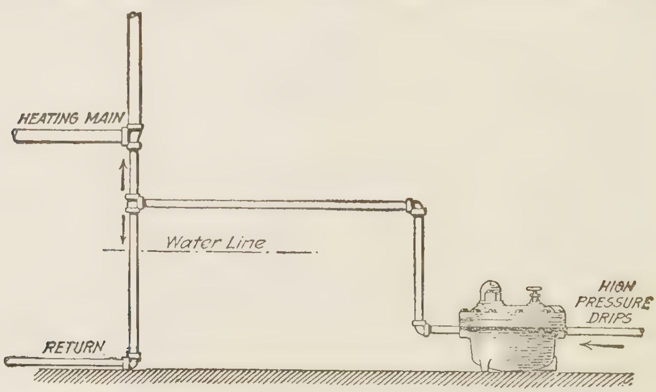


FIG. 2. ADDED VALVES AND COIL MADE HEATER A SUCCESS

off. The arrangement gives the desired temperature without excessive pressure or flow when the valve below the coil is opened wide, and no further adjustment is required when the upper valves are once set.

## PIPING HIGH-PRESSURE TRAP DISCHARGE TO HEATING SYSTEM

One bane of an engineer's existence is leaky traps. In every case some heat escapes in the form of vapor due to the release of the hot



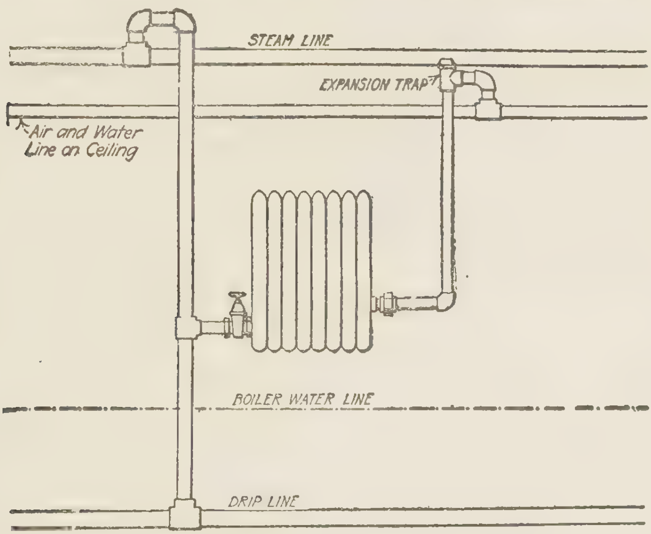

TRAP AND PIPE CONNECTIONS

water at the pressure at which the trap is working. In order to get the benefit of this vapor discharge it into the heating system. This is

easily done by connecting the vapor pipe of the drip tank, if there is one, with the heating system and placing a stop valve on the vapor pipe leading to the atmosphere, so it can be closed in winter and opened in summer. If there is no drip tank, the connection should be made to a steam riser, above the water line of the heating system, so that the vapor will ascend into the heating system and the water gravitate to the return pipe. The illustration shows how the connections should be made. In case the trap should blow through or the bypass be left open by a careless attendant, the steam is not wasted, as it goes into the heating system and less steam has to be passed through the reducing valve.

## RADIATOR CONNECTIONS

Whenever the air-line mains are run on the ceiling or above the radiation which they serve, the air valve, or thermostatic expansion

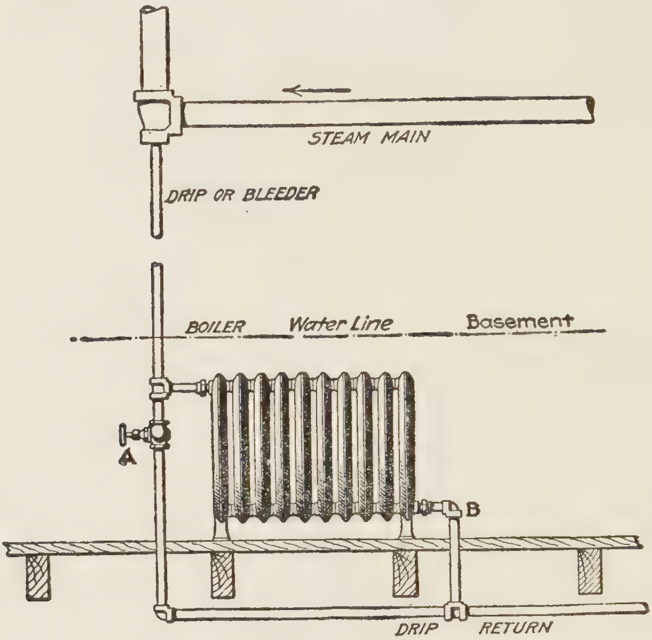



EXPANSION TRAP LOCATED ABOVE AIR LINE

trap, that regulates the discharge of air from the radiator must be above the main air line so that condensation will not collect above the air valve, requiring considerable pressure to drive it up the pipe into the main air line. Moreover, the piping leading to the air valve from the radiator should be larger than the usual ⅛-in. tapping provided in the radiator for this purpose. The radiator should be tapped out to at least ⅜ in. and pipe of that size used to prevent the pipe filling with alternate plugs of air and water that will not pass each other in ⅛-in. pipe. The illustration shows the location for the air valve.

## RADIATOR HEATED FROM MAIN DRIP

The accompanying sketch shows how some heat can be secured from a radiator located in a cellar or basement below the boiler water line on a low-pressure, gravity-return, steam-heating system. By closing the




RADIATOR BELOW BOILER WATER LEVEL

valve *A* all the water of condensation from the steam main will pass through the radiator. If a check valve is placed on the radiator outlet at *B*, any possible chance of a "come back" is prevented.

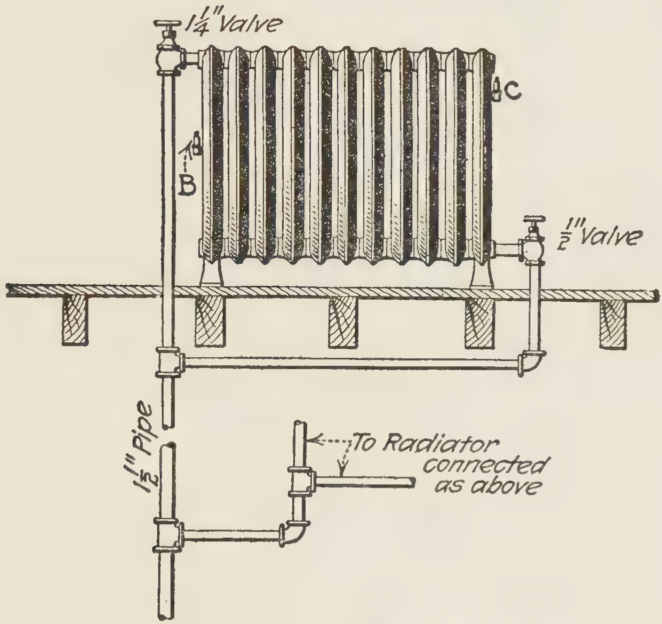
If it should be necessary to have the radiator cold at times, this will occur when the valve *A* is opened.

## USING STEAM IN HOT-WATER RADIATORS

Heating engineers design many systems in which the pipework may be used for steam heating, but engineers who do their own work sometimes put it over the heating expert by putting up a job that the latter will condemn as unworkable.

Such a system is shown. The job is in practical use; it is noiseless in operation with either low or high steam pressure. Hot-water radiators are used throughout and where connected as shown, the automatic air vent

is placed at *B*, which is the steam-entrance end. This is directly opposed to the usual way, as when the radiator is connected at the bottom on both ends the air vent is placed at *C*. The building is three stories high with a straight riser, a drip being placed on the low end of the main in the cellar. Radiators are on each floor and appear to give good results whether connected at the top or at the bottom on the inlet end.




HOT-WATER RADIATOR PIPED FOR STEAM

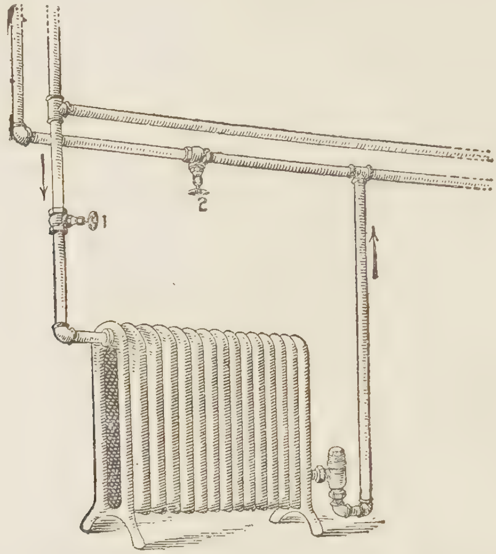
PIPING HOT-WATER RADIATOR

A 2-in. pipe runs to first-floor radiators, a 1½-in. pipe to second and 1¼-in. to third. Some are floor and others are wall radiators. Steam has been turned into this system at both low and high pressures, but in the latter case the steam was admitted slowly, the pressure being 60 lb. gage. In every case the system heated up with no hammering and was practically noiseless.

## RADIATORS LOCATED BELOW VACUUM RETURN MAIN

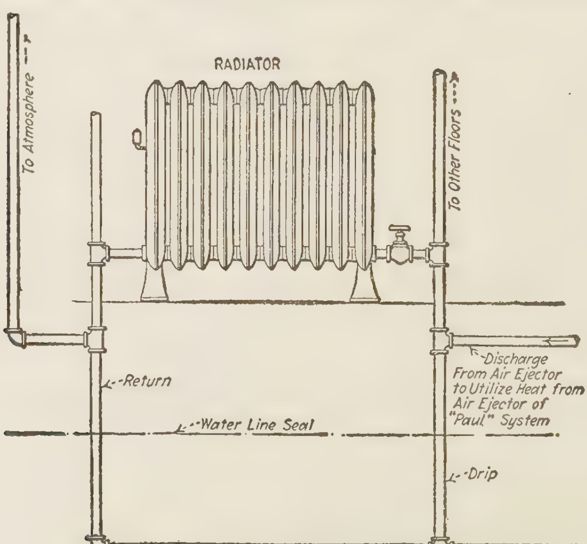
It is sometimes desired to heat a basement or cellar room where the steam and return piping is overhead and ceiling coils are objectionable. In this case a hot-water type radiator can be used to advantage by installing it so the drip of a return riser circulates through it in the same

manner as a hot-water radiator, as shown in the illustration. To operate, open valve 1 and close or partly close valve 2, the hot water will then pass through the radiator and give off heat.




## UTILIZING HEAT FROM EJECTOR EXHAUST

In buildings equipped with the "Paul" system in which a vacuum is carried on the air line from the radiators, the vacuum is usually pro-




PIPING OF RADIATOR

duced by means of a small steam ejector, and considerable heat is carried off by this ejector.

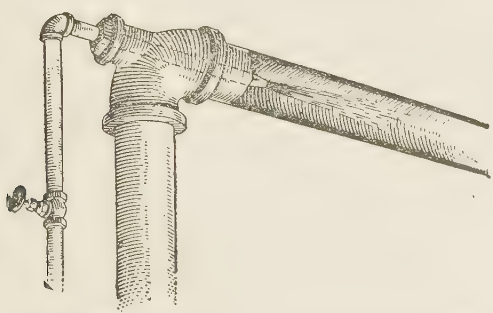
To utilize this waste heat a connection can be made to radiators supplying heat to a hall or stairway with the piping so arranged that these radiators cannot be shut off. Provision must also be made for separating the air from the water in the return piping. These radiators must be two-pipe, equipped with inlet and outlet piping so that the mixed steam and air can sweep through them. The illustration shows the application of this method to a two-pipe system with a wet return.

Another way to utilize the heat from the ejector is to discharge the exhaust into a return tank several inches below the water line, thus imparting the heat to the water in the tank, the air escaping at the open vent.

## UTILIZING WASTE EXHAUST STEAM

Two heating systems used exhaust steam. Into one of them more exhaust steam was discharged than could be utilized, and some of it was allowed to escape to the atmosphere; but into the other there was not enough discharged to supply the demand, so that live steam at low pressure had to be admitted through a reducing valve.

These systems were so connected that steam flows from one to the other. To overcome the friction in the pipe and increase the flow of steam a "siphon" was added. This draws steam from one system and



HIGH-PRESSURE JET IN HEATING SYSTEM

discharges it into the other, giving satisfactory results. The high-pressure steam pipe is only ⅜-in. with a ⅛-in. nozzle, hence it cannot use as much high-pressure (75-lb.) steam, and since it is discharged into the heating system it is not wasted.

## VACUUM HEATING IN MILD WEATHER

In vacuum heating systems the pressure should be decreased and the vacuum increased in mild weather and at night to "stretch out" the steam in the system, giving a lower pressure and temperature, thus radiating less heat.

With the Paul system very good results can be obtained by shutting off the ejectors in mild weather and at night.

## *SECTION XIII*

# MISCELLANEOUS KINKS

### BELT TIGHTENERS

A BELT tightener, to function properly, should be so designed that it will maintain nearly the same tension on the slack side of the belt under all loads. Others should really be called adjustable idlers, for if the pulley remains in a fixed position and a heavier load comes on, the pulling side of the belt will stretch and the slack side will become more slack, which will allow it to drop away from the tightener pulley. This will relieve the tension on the belt just at the time when it should have more tension, and it will slip and have a tendency to run off. A crown-faced pulley has nothing to do with the belt running to one side, for if a tightener pulley leads a belt to one side at all, it will run in nearly the same position under all loads.

Any idler pulley may be made to lead a belt a little to either side by simply throwing the idler out of line with the center line of the belt. Imagine a belt standing still and a pulley being rolled along on it. If it is in line with the belt it will stay on, but if it be turned a little to one side it will run off. Suppose the belt moves and the pulley is held in one place but turned a little to one side, as before. It is evident that the pulley cannot run to one side, therefore it will exert a pull on the belt in the opposite direction, which will tend to run it to one side until the force exerted is counteracted by the pull of the crowned faces of the drive and driven pulleys tending to hold the belt on, in which position it will remain.

The type of tightener is unimportant so long as it is allowed to play freely and maintain an even tension on the belt; but a swing tightener—that is, a rigidly built frame lying parallel to the belt and hinged at one end of a support, the other end carrying the pulley—is preferable as it is of simple construction, plays more freely and is easier of adjustment for leading the belt.

It seems to be the universal practice to set the tightener pulley as

close as possible to the driven pulley. The reason generally given, outside of it being customary, is that it gives the belt a greater arc of contact on the small pulley. With the tightener placed close to the driven pulley, an increase of load will stretch the pulling side of the belt and the extra slack will run off at the driver first. This slack having nearly the full length of the slack side of the belt, before it reaches the tightener the belt will start flapping and the tightener will play up and down. When the tightener rises quickly, it may be carried too far by its momentum, with a resultant release of the tension on the belt, allowing it to slip. With a belt running at high speed excessive flapping will often entrap a little air between the belt and the pulley face, which will greatly reduce the contact area. When the tightener is close to the driver, it will take care of the slack the instant it runs off the driver, and the belt and tightener will run much more smoothly, which will more than offset the advantage of the extra arc of contact obtained by the former method.

## LOSSES IN BELT TRANSMISSION

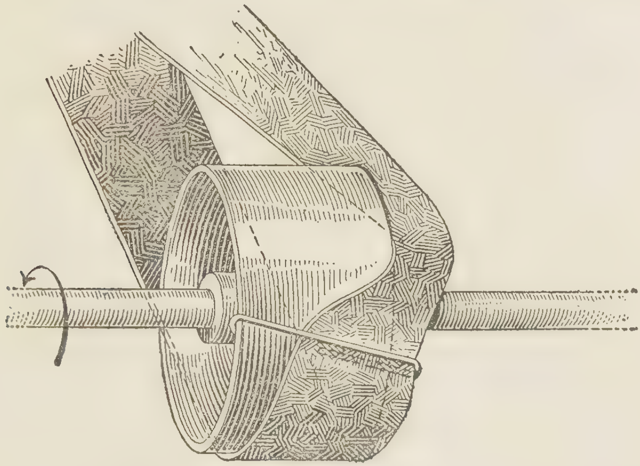
There are two factors of loss in belt transmission that are equal to, if not greater than, any two factors of loss in power production; namely, excess tension and belt slip. The first is a source of lost power and increased cost of maintenance, and the second results in lost power, loss of production and increased maintenance cost.

The practice of increasing the tension to reduce the slip does not materially reduce the loss. It shifts it from loss of production through slip to loss of power from excess tension. If the statement that "each 1 per cent of slip means a loss of 1 per cent of power" were changed to "each 1 per cent of slip means a loss of 1 per cent of production," a more accurate idea of the loss would be expressed. If the loss through slip is converted into a loss of time, then each 1 per cent of slip means a loss of 1 per cent of the operating time, and hence a loss of three days in each 300-day year. Since the loss through slip, under ordinary conditions, ranges from a minimum of 5 per cent to more than 15 per cent, we are confronted by a minimum loss of 15 days' production each year. Add to this the loss of power from excess tension, and the bill becomes considerably larger.

## PUTTING ON HEAVY BELTS

Take a piece of $\frac{1}{4}$- or $\frac{5}{16}$-in. round iron and bend it, as shown in the small sketch. Hook the short end over the edge of the rim of the

pulley and the long end under the belt as indicated. Start the engine slowly, and when the belt is on it is not necessary to stop, because the short end of the hook will straighten out and disengage itself. It is a good plan to use a rod of as light weight as will answer the purpose,



METHOD OF REPLACING BELT ON PULLEY

since it will straighten out and free itself with less stress on the belt. The iron hook then falls to the floor.

## ALARM TO SHOW FAN TROUBLE

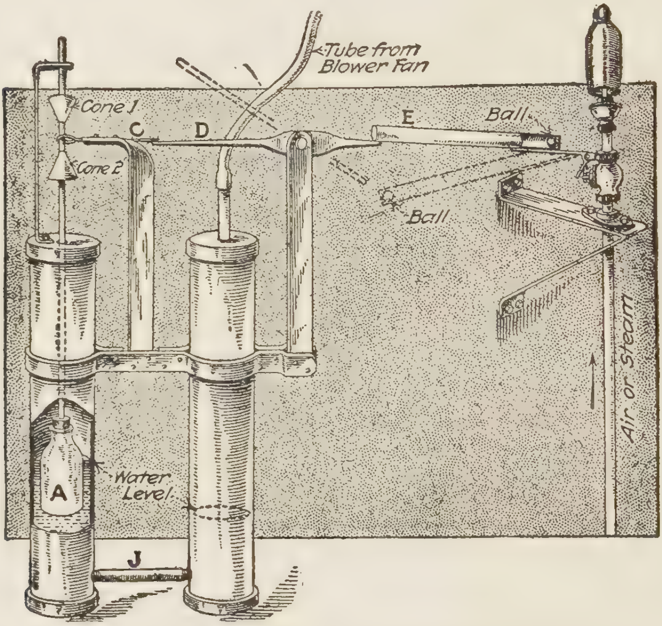
The illustration shows an alarm that has proved satisfactory.

In one particular installation the motor driving the fan derives its current from a line that also serves several other motors. The common source of energy is the main power plant of the company. In consequence, if the main circuit-breaker goes out, the fan motor as well as the other motors stop.

As seen from the diagram, the apparatus is simple and can be built by almost anyone. Two containers of equal size, or nearly so, are placed side by side and connected together near the bottom by the pipe *J*. Both containers are partly filled with water. The top of the one is connected to the pressure side of the fan and the top of the other is open to the atmosphere. A large water gage is thus formed.

On the water in the open leg of the device is placed the float *A* (in this case a tightly corked bottle), which carries a small rod that passes upward through suitable guides. Upon this rod are placed two cones, one pointing up and the other down. Between these cones and encircling the rod is the trip slide *C*, which is so arranged that an ex-

cessive movement of the cones either up or down will cause the rod *C* to move to the left. Such a movement will trip the walking beam *D*, which will then rotate under the weight of the hollow lever *E*. This lever which is attached to the lever of the whistle, contains a steel or iron ball. When the tube is in normal position, this ball rests against the end nearest the whistle. When the outer end of the lever is released from its support and swings downward, the ball rolls to its outer end, thus bringing sufficient weight into action to blow the whistle, which is under 120 lb. air pressure.

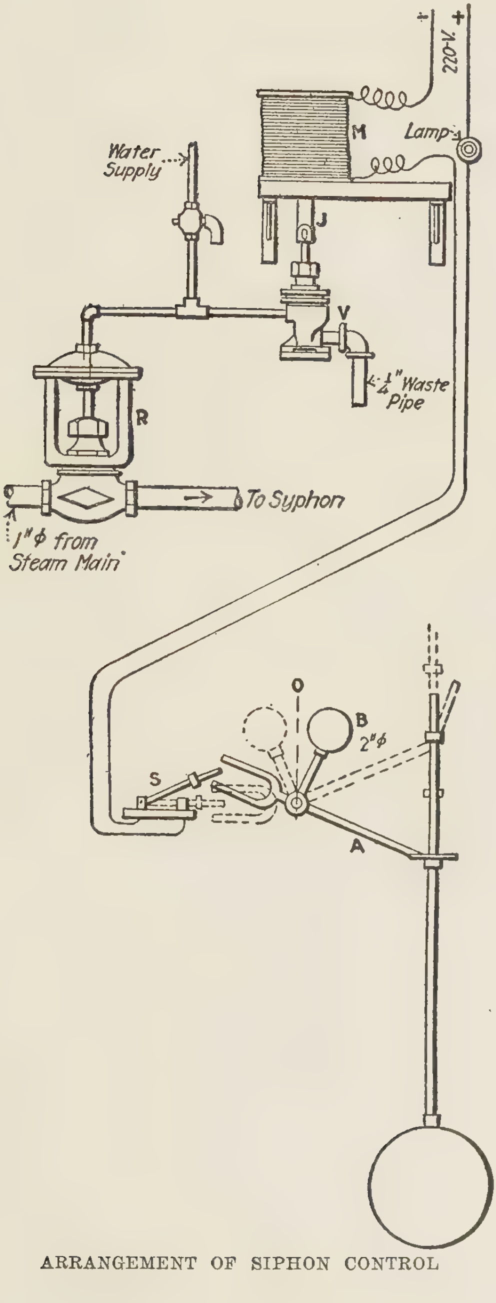



DETAILS OF ALARM TO WARN OF FAN TROUBLE

It will thus be apparent that so long as the fan runs at rated speed and the resistance of the mine is normal the surfaces of the water in the two containers will be at different heights, but practically steady, and the float *A* will support the cones at nearly a constant point. When for any reason, however, the fan stops or the resistance of the mine greatly decreases (as through short-circuiting of the air), the relative elevations of the water surfaces change. The float *A* will thus fall and the whistle will sound until the apparatus is reset.

## AUTOMATIC CONTROL FOR SIPHON

A sump-hole in a mill building drained by a siphon, located in the engine-room basement 200 ft. distant, was a continual nuisance, as




ARRANGEMENT OF SIPHON CONTROL

the mill basement was flooded or steam blew needlessly into the sewer. To remedy this condition, an automatic control made from parts picked up around the plant was devised and installed, as shown by the illustration.

As the sump fills, the float raises the forked lever *A*, causing the lead ball *B* to move toward the center line *O*. When the ball *B* crosses the center line, it falls to the dotted position and closes the switch *S*. Current then flows from the power lines through a lamp in series with the magnet *M*, which causes the valve stem of the valve *V* to rise and allows water to flow through the waste pipe. The pressure on the diaphragm of the steam valve *R* thus being removed, allows the valve to open and steam to flow to the siphon.

The siphon continues to operate until the water level falls and the float pulls the weight *B* past the center line *O*, when it falls and opens the switch *S*. As the current is then cut off, the magnet core drops, closes the valve *V* and the water pressure builds up on the diaphragm of the valve *R*, closing the valve and shutting off the steam.

It is well to allow 3/8 in. lost motion in the joint *J*, so as to give a hammer-blow effect to the movement and overcome any tendency to stick in the packing on the valve stem. A globe valve could be used instead of the trap valve *V*, but it would not open so easily, owing to the pressure above the disk holding it to the seat. This would be no drawback if the magnet was capable of opening it.

## AUXILIARY SOURCE OF GLAND-SEALING WATER

In a turbo-generator station using a certain type of machine, there is need for soft water to seal the turbine glands. The builders of this particular machine specify that sealing water shall be furnished at a pressure equivalent to a 10-ft. head. If the relative levels of the spray nozzles and turbine permit, the spraying pressure may be used to supply the glands directly. In one plant this condition existed, and a supply tank as shown in Fig. 1 was installed, which gives a reserve supply of soft water. The float valve keeps the tank full and at the same time prevents waste.

The tank could be fitted with another float valve at a lower level, which would admit water from the general service lines in case the supply of soft water should fail for any reason. The tank could also be fitted with a low-water alarm of any desired type, as a bell or red light. The use of spray-pond water in this way does not really remove any water from the pond, for practically all the loss from the glands is drawn into the turbine, where it mixes with the condensed steam and returns to the pond.

If the spraying pressure is not sufficient to supply the glands directly, a hydraulic ram may be used instead of a steam pump to pump water

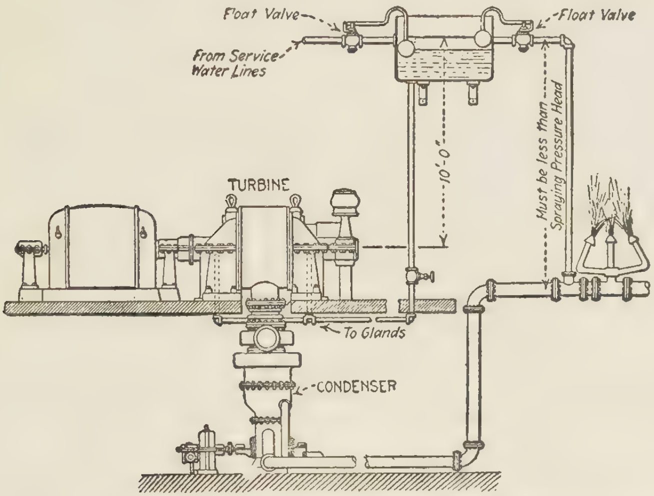



FIG. 1. PIPING OF GLAND-WATER SYSTEM SHOWING RESERVE SUPPLY TANK

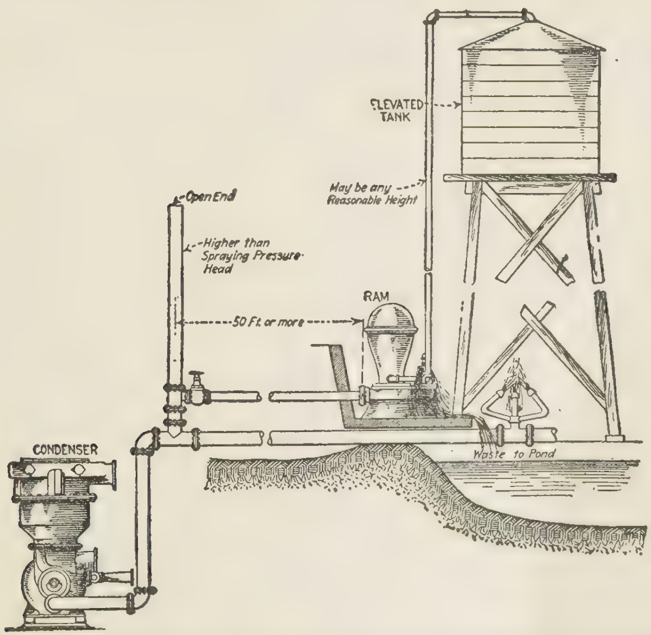



FIG. 2. RAM FOR SUPPLYING GLAND WATER, CONNECTED WITH STANDPIPE

to the supply tank. It would get its working head from the spray pressure and so utilize energy already available. Its waste should re-

turn to the spray pond, so that no water would be lost from the system.

In one case the use of a steam pump was avoided by installing a hydraulic ram (Fig. 2). The ram operates with energy already available, and it uses so little water that it has no noticeable influence on the spraying. The stand-pipe is necessary to give free vent to the air that is mixed with the water from the condenser, so that the pipe feeding the ram shall be filled with solid water. The ram is set on the intake well of the pond, and in a sheet-iron pan in such a way that its waste water all returns to the pond. Hence no water is taken from the circulating system excepting that actually pumped into the tank.

## BACKING OUT BROKEN SETSCREWS

The backing out of a broken setscrew was accomplished by drilling a hole in the setscrew and then turning a tool as illustrated into the hole and backing out the screw. This tool has a left-hand thread or spiral

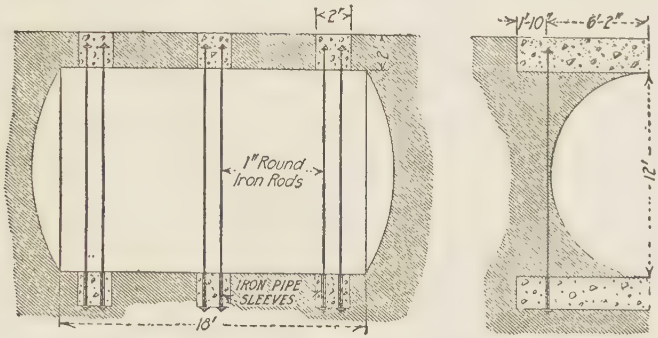
TOOL FOR BACKING OUT BROKEN SETSCREW

and can be made from a piece of square stock, with a slight taper. The thread is formed by heating the metal, holding one end in a vise and twisting the other end clockwise, forming a rough left-hand thread. It can be finished off if necessary with a file.

## BURIED FUEL OIL STORAGE TANKS

At one plant there were installed two cylindrical steel tanks, each of 15,000 gal. capacity. The tanks measured 12 ft. in diameter by 18 ft. long. It was planned to bury them with the tops 2 ft. below ground level. As the location of the plant was within a few hundred feet of a river and on made ground containing a great deal of surface water, it therefore became apparent that concrete foundations must be provided to prevent settling when the tanks were full, to avoid straining pipe connections. Equally important was the problem of the tanks when empty, for then the tendency would be for the surface water to raise them.

The method used becomes apparent on referring to the accompanying sketches. For each tank three concrete base supports were provided, at the front, center and rear respectively, and on top of the tanks similar concrete courses were poured. The novelty of the method lies




METHOD OF ANCHORING BURIED TANK

in the use of the 1-in. iron rods connecting the upper and lower courses, so that, when the tanks are empty, the tendency to rise is arrested not only by the upper courses but also, through the connecting rods, by the lower courses. The tanks were rigged up separately to avoid unequal strains should one be empty when the other was full. The rods extend through the bottom courses. This was done so that the tank could be placed in position before the rods were installed. The concrete courses were made 2 ft. by 2 ft. by 16 ft. long.

## CEMENT-LINED STOKER COAL CHUTES

The taper chutes connecting the storage hopper and the stoker hoppers have a tendency to wear in a short time, and as an experiment they lined them with mortar made of one part cement and two parts sand. The mortar was 1¼ in. thick and reinforced with common poultry wire. The chutes being on a steep angle, it was necessary to place the material rather dry in order to hold.

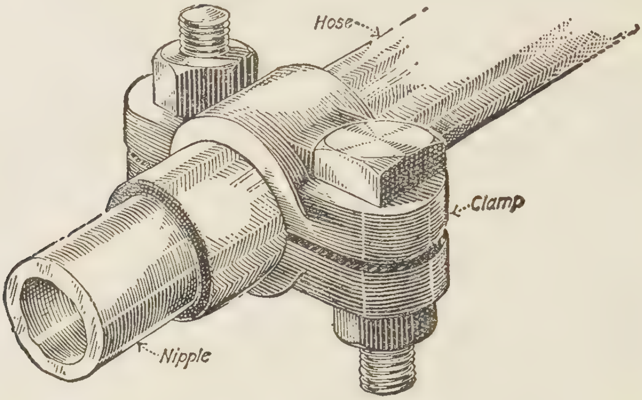
Recently, one of these chutes was removed and an examination showed that the mortar had not cracked, nor did it show any signs of wear, although it had been in use for at least a year.

## CLAMP FOR HIGH-PRESSURE HOSE

A method of repairing a leaky hose that is employed in the mines is as follows:

The hose is cut at the leak and for a ¾-in. hose a ½-in. nipple 6 in. long is inserted halfway in the hose. A ¾-in. nipple 7 in. long is used

for a 1-in. hose, such as is illustrated herewith. The hose is clamped to the nipple by the type of clamp shown. Sometimes a marlin spike is used in the hose to enlarge it a little.

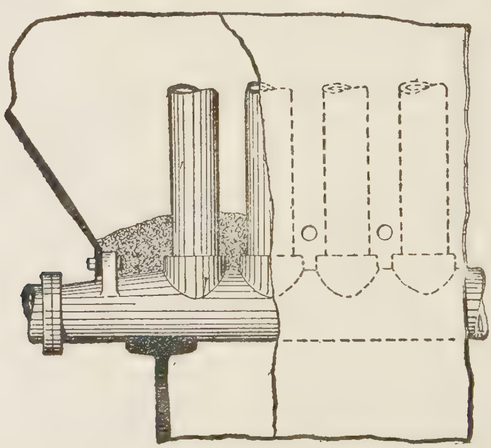



HOSE COUPLING CLAMP

Under high pressure and where the hose is subject to hard usage, several strands of wire can be run on each side from one coupling to the other and twisted as desired.

## CLEANING DEPOSIT FROM ECONOMIZERS

In working economizers the soot comes off the tubes and the flue ash lodges at the base of the tubes and prevents the correct working



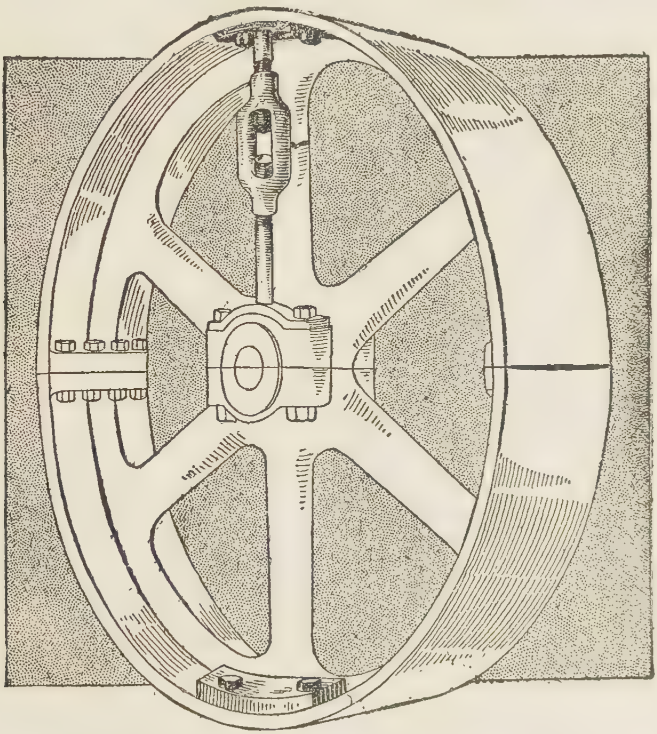
CLEANING HOLES IN CASING AROUND ECONOMIZER

of the scrapers, necessitating occasional cleaning from the inside, which can be done only when the machine is practically cold, and it is always

a dirty job. To overcome this trouble drill 1¼-in. holes in the casing in line with the space between the tubes and about 6 in. above the bottom headers. By means of a ½-in. hooked rod and air or steam jets the space between the headers can be kept free of soot and in this way get the benefit of the full amount of heating surface. The holes are kept plugged when not in use.

## BROKEN SPOKE REINFORCED

A flywheel on a steam-driven exciter cracked. It was reinforced as shown in the illustration. One end of a 1-in. turnbuckle rod was welded to a strap ⅝ in. thick and 8 in. long formed to fit the inside



TURNBUCKLE ROD HOLDS THE RIM OF A WHEEL

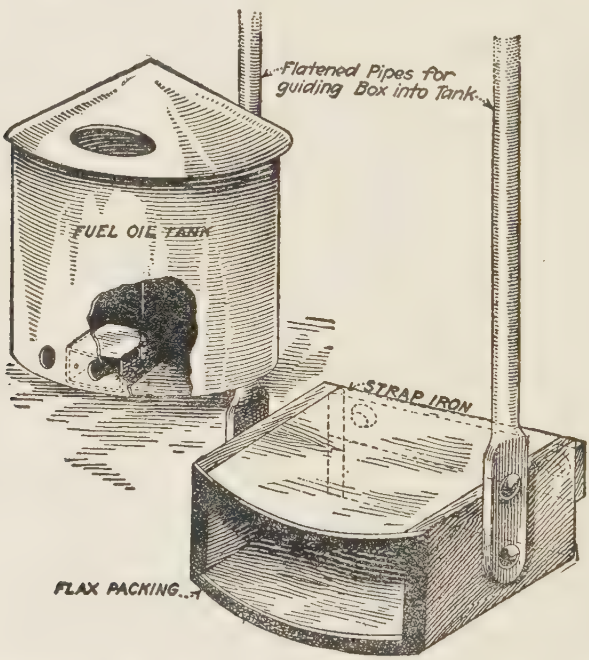
of the rim and bolted on. The other end of the rod was welded to another strap of the same thickness formed to the hub and long enough to reach under the hub bolts. A strap of iron was fastened to the rim on the opposite side of the wheel to act as a counterbalance.

## CONNECTING AN OIL LINE TO A FUEL-OIL TANK

A crude-oil tank, 20 ft. deep and 30 ft. in diameter had but one feed line going to the boiler oil burners.

Another oil line was wanted, and the problem was solved by putting a 4-in. connection in the side of the tank at the bottom.

A wooden box was made, 14 in. square by 8 in. deep, with the face made to fit the curvature of the tank. The edges of the box that came next to the tank were lined with flax packing and held in place with nails driven well in so as not to hold the packing away from the tank. A piece of strap iron was then screwed to the back of the box, and two ⅝-in. holes were drilled and tapped through both. This plate was for the purpose of pulling the box up to the side of the tank by means of bolts extending from the outside.




SHOWING HOW THE HOLE WAS DRILLED IN THE TANK

Next, two lengths of pipe, each flattened at one end, in which two holes were drilled, were bolted one on each end of the box, so as to guide and let it down to the desired position in the tank. Corresponding holes were drilled in the tank to match the tapped holes in the box, so as to draw the box with flax packing tight against the tank. The holes in the tank were carefully drilled with an air drill running at slow speed so as not to cause heat or produce a spark, which would sub-

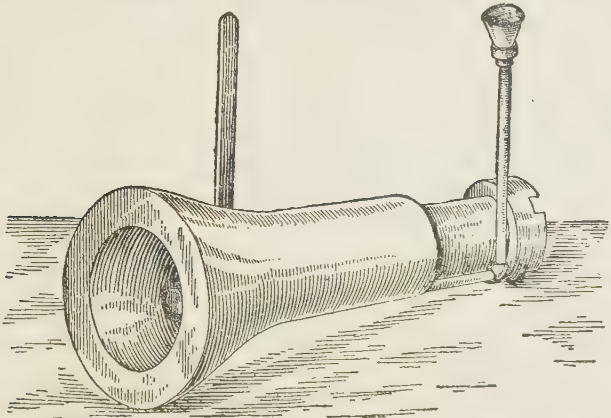
ject the oil tank to the danger of fire. As soon as each hole was drilled, a wooden plug was inserted.

When all was ready, the box was lowered, through a manhole at the top of the tank, to its place corresponding to the holes drilled in the tank. The holes in the box were countersunk so as to be easily located when putting the bolts through after the box had been lowered to position, the bolts being inserted in the holes in the tank after the wooden plugs had been pulled out one by one.

The box was then drawn up to the tank securely, the plug in the center hole was pulled, and the oil in the box was drained out. A 4-in. flange was placed against the tank and central with the box. Then the bolt holes were scribed, also the bore of the flange opening. The center was drilled out with a small drill, and the bolt holes were drilled. The flange was then placed after putting an 1/8-in. asbestos sheet gasket between the brass flange and the tank. The flange bolts were put in place from the inside of the tank by means of the flange opening in the tank and were drawn up tight. The flange was made of brass so as to obviate any chance of breaking when tightening. A nipple had been screwed tightly into the flange before bolting it to the tank, so as not to have any difficulty in screwing it in later, in case the flange should spring in bolting it to the tank. A valve was screwed to the nipple and then closed. The bolts were unscrewed from the box, leaving it free, and the bolt holes in the tank were tapped and plugged with patch bolts.

## CURE FOR A "BALKY" HYDRAULIC JACK

In attempting to use a hydraulic jack to force a new crankpin into the crank disk of an ammonia compressor it was found that the jack would

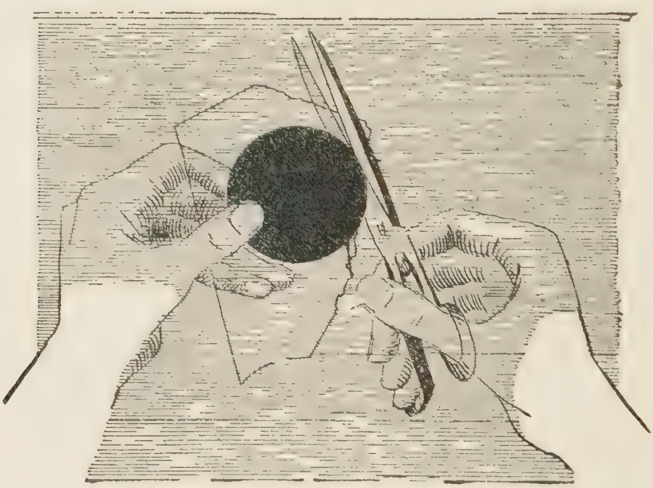


PIPE TO CREATE A HEAD OF FLUID IN THE JACK

not work when placed in a horizontal position. It was reasoned that if the valves and plunger could be kept covered with oil (oil was the fluid used in the jack) it would "have to work." so the vent plug was removed from the top of the oil reservoir and a $\frac{1}{8}$-in. pipe connected to the opening, as shown, thus giving the oil some "head" pressure, which kept the valves covered, and the jack went to work immediately as well as when in a vertical position.

## CUTTING GLASS UNDER WATER

Cutting a glass dial with a pair of scissors may seem difficult, but it is not, although the job must be done under water and both the glass and the scissors must be submerged. A good way is to first cut a paper



CUTTING GLASS UNDER WATER

the size or shape of the glass desired; place it on the under side of the glass for a pattern. It is not expected that it is possible to cut through the center of a large piece of glass, but by trimming a little at a time a good job can be done. The cutting sensation is a good deal the same as that of cutting cardboard.

## DEVICES FOR OVERHEAD DRILLING

Fig. 1 shows a kink used for overhead drilling if many holes are to be drilled. In one instance an old copying press was used; the plate was discarded and the screw and wheel reversed, as shown. At *A* a coupling sleeve was made to fit on the screw and the electric drill.

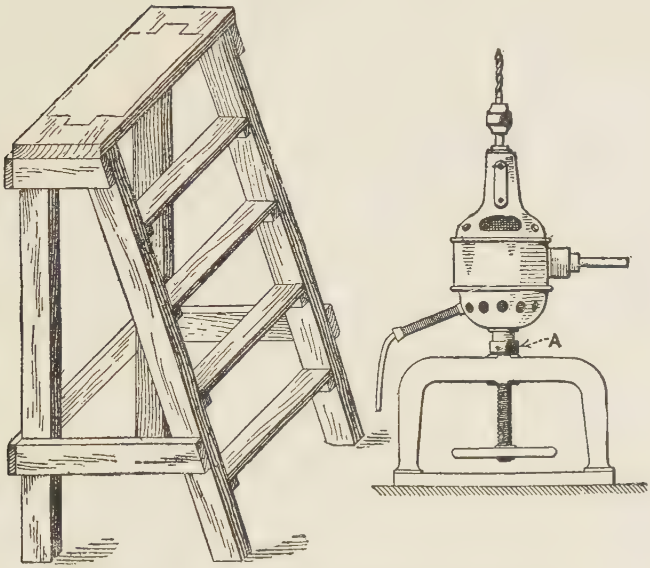



FIG. 1. RIG FOR OVERHEAD DRILLING

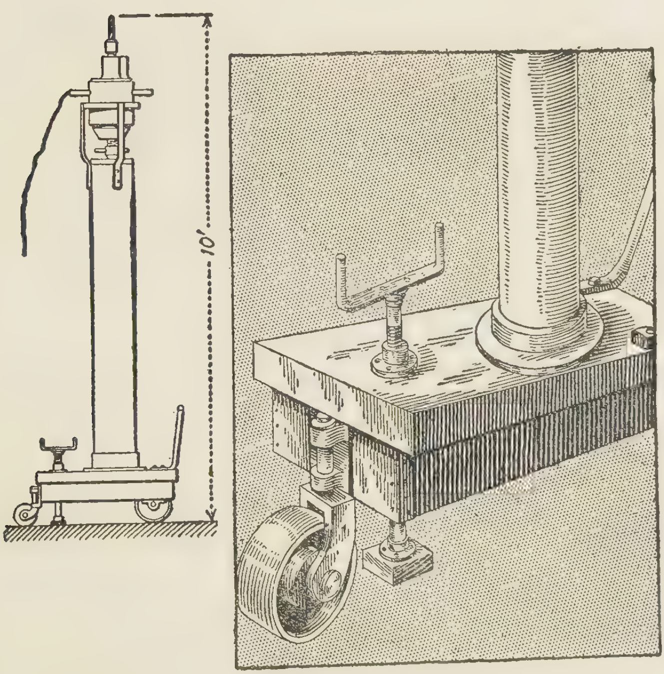



FIG. 2. DRILL MOUNTED IN VERTICAL POSITION ON TRUCK

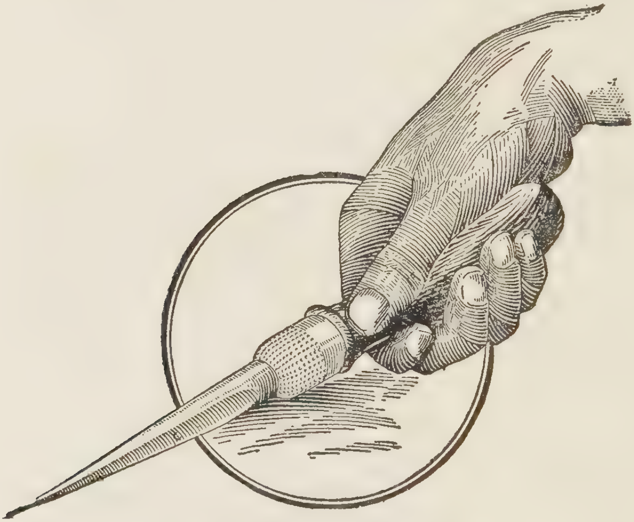
After removing the breast plate, the sleeve was easily made to fit in its place. The press was placed on the stand when drilling.

Another drilling device is shown in Fig. 2. It consists of a large electric drill weighing about 100 lb., placed on the drill stand as shown. On the top of a small truck was fastened a piece of 6-in. pipe the right length for the drill to rest on top and just clear the work to be done. A cast-iron disk and a cage to keep the drill in place completes this part of the rig.

To prevent vibration from making the truck creep, a brake in the shape of a threaded piece of pipe running in a flange and carrying a wooden shoe at the bottom can be applied. The friction of the shoe on the concrete floor will be sufficient to keep the truck where set.

## EASILY MADE FERRULES

Sometimes a ferrule may be lost from a tool handle or one is needed to put on a home-made handle which is likely to split if no ferrule is



THIMBLE USED AS A FERRULE

used. A ferrule can easily be made from an old thimble by cutting or drilling a hole in the end to fit the tool on which it is to be used, and applying it to the handle as shown.

The end caps from burned-out inclosed fuses come in handy for ferrules for small tool handles. Usually, there are different-sized fuses in a plant, the caps on the 15-ampere 250-volt ones being ½ in. in diameter, gradually increasing in diameter as the amperage increases.

The 200-ampere 250-volt fuses have caps 1½ in. in diameter, and the weights of the caps are just about right for the different-sized ferrules.

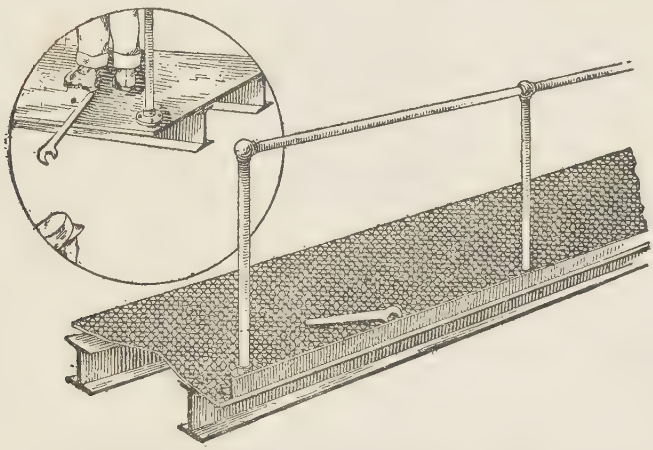
## EQUALIZING MACHINE SPEEDS

Several machines may be run from the same lineshaft, all with the same combinations of pulleys, but owing to lost motion or slippage of belts the total output of the different machines will vary considerably during the day's run.

To equalize the speeds of all the machines, rivet leather of the necessary thickness on the face of the driving pulleys, thus equalizing the speed to make the output of each machine the same.

## ELEVATED PLATFORM SAFETY GUARD

In connection with engines, switchboards, etc., having elevated platforms or stairways, it is advisable to guard against accidents from tools



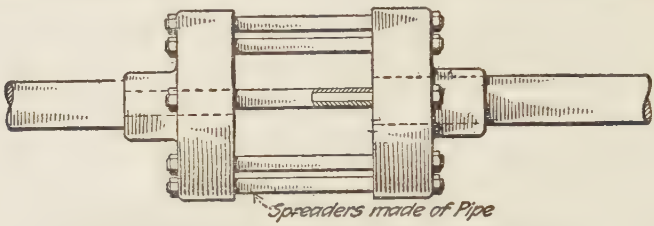
ANGLE-IRON GUARD ON ELEVATED PLATFORM

rolling or being kicked off the edge of the platform and injuring some person or machinery below. An inexpensive but effective guard is made from 2- or 3-in. angle iron bolted to the edge of the platform, as shown in the illustration.

## EMERGENCY SHAFT REPAIR

One way in which an emergency shaft repair can be made is shown in the illustration. First procure new coupling bolts longer than the original ones and an equal number of pieces of ¾-in. pipe cut to fit and to act as spreaders between the halves of the coupling. If the load

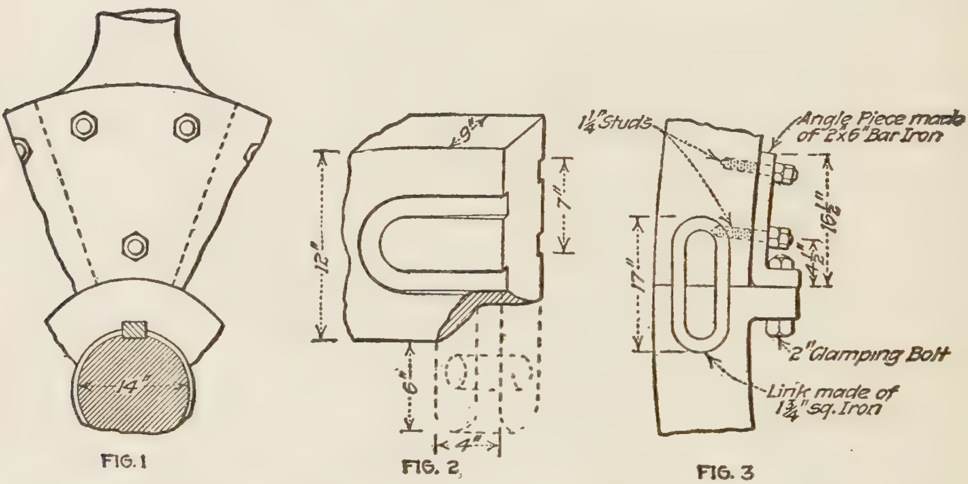
on the shaft is heavy, it may be advisable to drill additional holes and use a larger number of bolts than were in the coupling originally.




HOW SPREADERS WERE APPLIED TO COUPLING

## REPAIRED FLYWHEEL LUG

A 20 ft. diameter flywheel was made in eight segments, each segment being cast integrally with a single spoke. The eight spokes were secured to the hub by clamping them between cheek-plates as indicated




FIGS. 1 TO 3. SHOWING METHOD OF REPAIRING BROKEN LUG ON FLYWHEEL
Fig. 1. Fastening of arm at hub. Fig. 2. Break in lug at rim. Fig. 3. Manner of repairing break

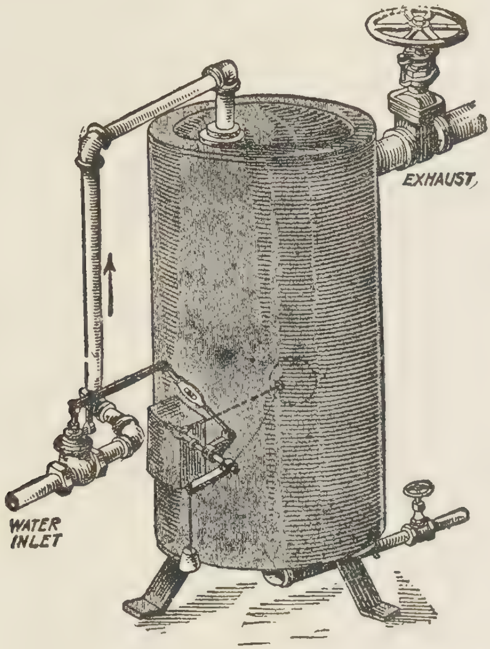
in Fig. 1. Each rim-joint was fastened with a bolt and with two wrought-iron links shrunk into recesses in the sides of the rim.

A clamping lug on one of the rim segments of the wheel was broken off as shown in Fig. 2. Fig. 3 shows how it was repaired.

## MAKING A FLOATLESS FLOAT FUNCTION

If the float in a heater has a leak, and will not rise and shut off the water, the heater will fill until the water will run out at the over-

flow. To tide over such an occurrence, make a clamp and fasten it to the rod that the float is connected to and hang weights on the end of the clamp, acting in the opposite direction, to balance the extra weight of the float. The float is then held partly out of the water, and as the




LOGGED FLOAT HELD UP BY OUTSIDE WEIGHT

water recedes the weight of the float overbalances the outside weight, closing the valve, and the water is held at the right height in the heater.

## HANDY PACKING CUTTER

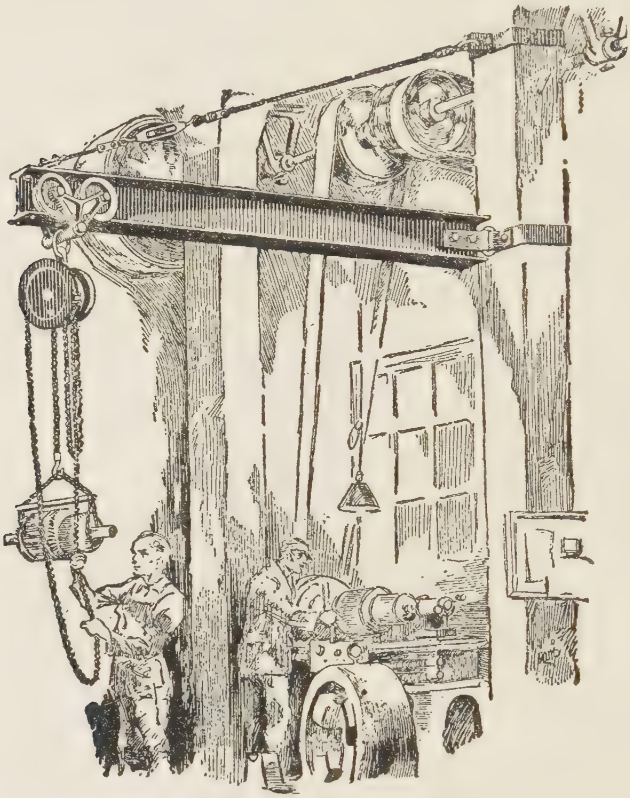
An old plug tobacco cutter (or a new one for that matter) makes a good tool to have in the engine room, for cutting all kinds of packing for stuffing-boxes and pump plungers.

## A HANDY SHOP CRANE

In the power plant repair shops where there are no cranes it is always more or less of a problem how to handle pieces of equipment of only medium weights, to say nothing of the larger parts. A home-made monorail crane shown can in such instances be built.

This device consists of ordinary 4- or 6-in. I-beam, one end is fastened

to a column by a two-part band, the latter made so that it can be tightened on the column by two bolts. The outer end of the boom is supported from the top end of the column by a two-part band. On the



CRANE INSTALLED IN SHOP

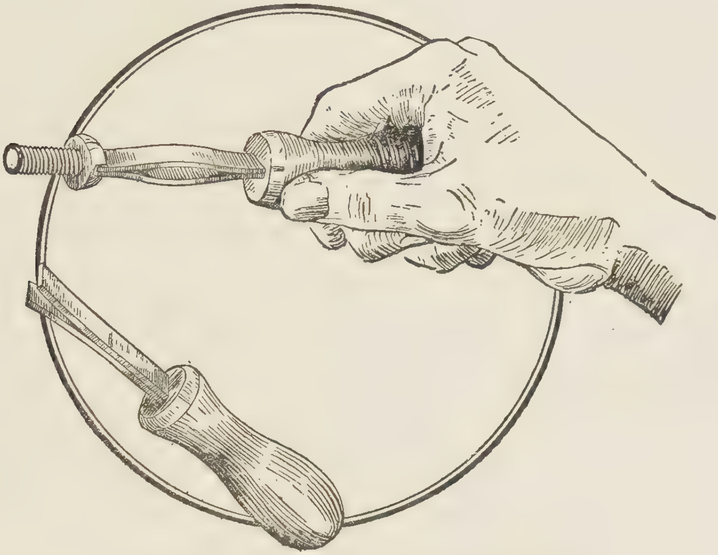
I-beam is placed a trolley such as can be purchased at most any machinery supply house, and from this trolley a chain fall is supported.

This crane can be operated through a radius of at least 180 deg. By putting up a special mast to support the boom from the crane it can be so constructed as to have a 360-deg. travel. The length of the boom will depend upon how high the ceiling is; the boom rod should make not less than about 30 deg. with the boom and 45 deg. is better.

## HANDY SCREW HOLDER

It is sometimes inconvenient to start a small screw into a hole when it is impossible to start it with the hand. A handy screw holder can be made by placing two pieces of spring steel in a handle, as shown.

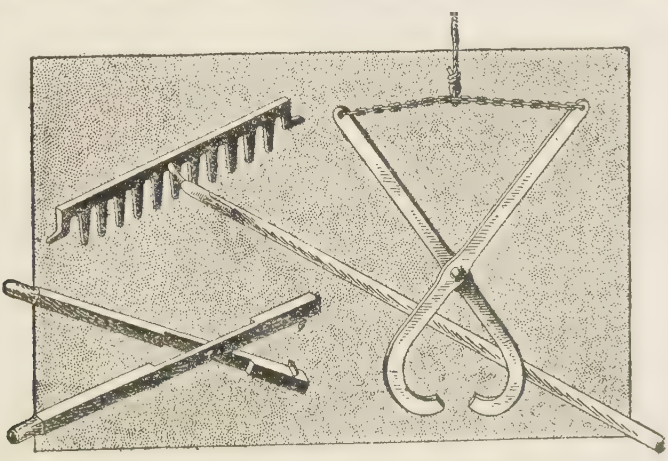
Then, by pressing the two open ends together and putting them in the screw slot, the tendency of the ends to open will hold the screw and it can easily be started in the hole and then tightened with the ordinary screw driver.



SCREW HOLDER AND ITS APPLICATION

## HANDY TOOLS FOR THE WATER-POWER PLANT

The illustration shows three devices that have proved their worth. One is a modified rake used for pulling leaves from the trash racks,



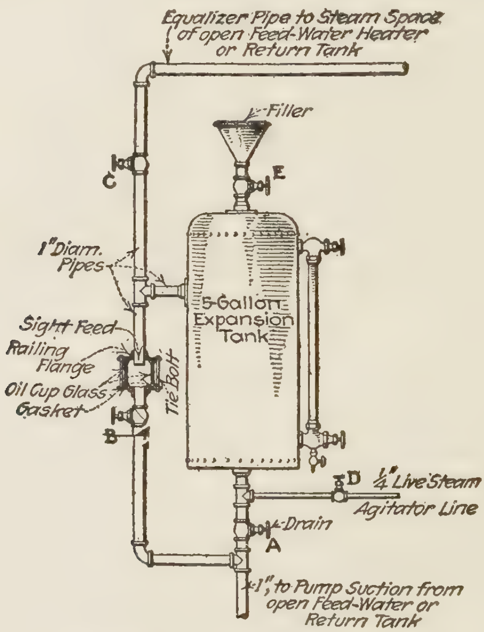
HOME-MADE TOOLS FOR WATER-POWER PLANT

made by bending the two outside teeth at right angles to the others so that the teeth of the rake are allowed to slip in between the bars of the trash rack only the desired distance, and this distance is made less than that from the outer edge of the rack bar to the bolts that hold the rack together. This arrangement eliminates the chances of the teeth catching the bolts that hold the bars.

Another handy tool is an ice hook that can be quickly made in an emergency and serve its purpose admirably. It is used to pull from the racks cakes of ice that would otherwise be difficult to dislodge. It is made of two pieces of wood bolted together as shown. The long ends are used as handles, and in the other ends sharpened spikes are driven. When the ice is too heavy to handle with this device, regular ice tongs can be used with a rope to a tackle block.

## HOME-MADE COMPOUND FEEDER

The sketch shows a boiler-compound feeder that is self-explanatory, and the directions for its use are as follows:




PIPING OF COMPOUND FEEDER

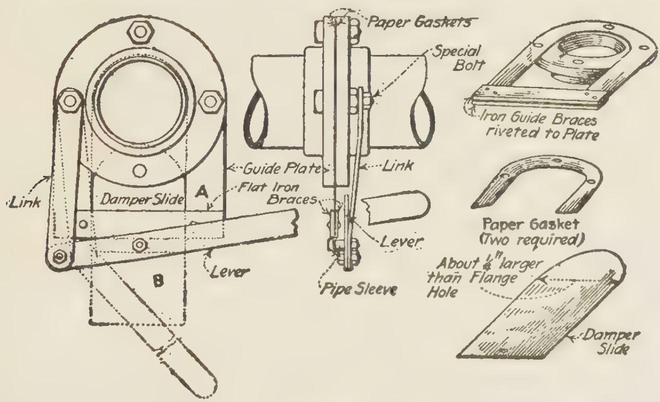
The expansion tank is placed above the water line of an open feed-water heater or return tank and piped as shown. To operate, put the amount of compound required for twenty-four hours, mixed with sufficient water to flow freely through the filler funnel, into the tank,

valves *A, B, C,* and *D* being closed. Then put more water in the tank to bring the level up to the overflow pipe. Next close valve *E* and open valves *B* and *C* and then the valve *D* just sufficient to keep the tank agitated and the condensation overflow through the pipe and valve *B* into the pump suction.

When it is necessary to refill the expansion tank, open valve *A* and allow sufficient liquid to flow into the pump suction to make room for the new charge. Then close the valves *A, B, C* and *D,* fill through the valve *E,* and proceed as before.

## HOME-MADE FLANGE DAMPER

The sketches show the construction of a damper for a low-pressure pipe line, as for instance a blower intake or outlet or an air inlet to a furnace, such a damper being frequently necessary to regulate the amount of air passing through the line. The construction is simple but effective, being a U-shaped piece *A* of heavy sheet iron, either black or galvanized, clamped between two pipe flanges in the line. A slide *B* cut from the same material fits into this U, and its width is made about




DETAILS OF LOW-PRESSURE PIPE-LINE DAMPER

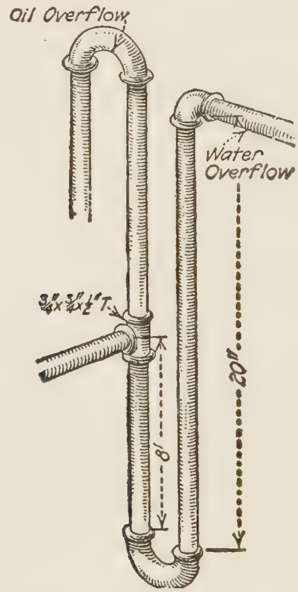
a quarter of an inch larger than the diameter of the flange opening. A gasket of heavy paper set in shellac, paint or other adhesive is clamped between each flange and the outer plate; this gives clearance to the slide. Usually it will be necessary to leave out one of the flange bolts to allow room for the damper slide to enter.

The arms of the U-piece *A*, or guide plate, extend out and serve as guides, two flat iron trips being riveted across the outer ends as shown. The operation of the damper will be greatly facilitated if a lever and link are connected as shown in the sketch, the link being pivoted on one of the flange bolts, which is made longer for the purpose. By using

the lever, the slide can be made to work tightly enough to allow of its staying wherever placed as well as to almost entirely prevent the leakage of air.

## HOME-MADE OIL AND WATER SEPARATOR

A mixture of oil and water from an air pump was caught in a pail and emptied into a sewer as the oil, about a pint to a pailful, was not considered worth bothering with. Finally an oil and water separator was made of old ¾-in. pipe and fittings picked up about the plant, as shown in the illustration. It works on the principle that, water being



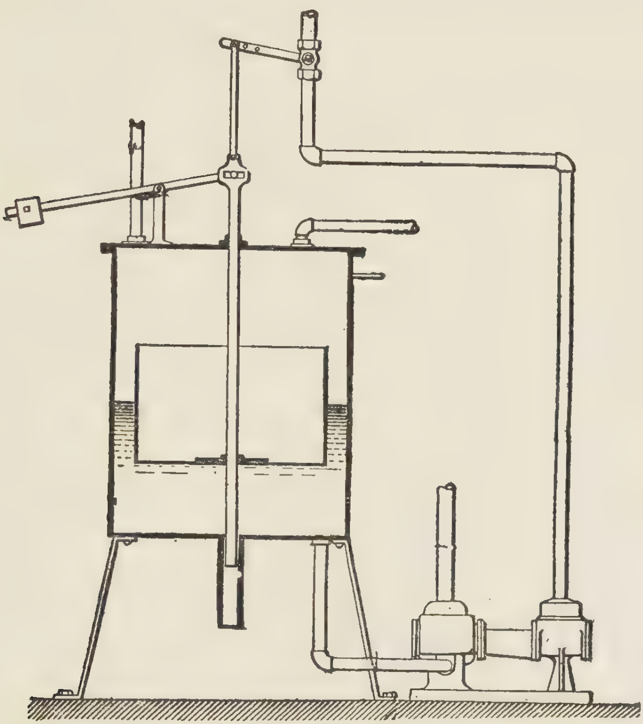

SEPARATOR PIPING

heavier than oil, a column of water will balance a higher column of oil; therefore as the mixture of oil and water flows in at the tee and the piping becomes filled, the oil will naturally rise in the vertical pipe immediately above the tee, forming a column higher than the water overflow pipe. The operation will then be continuous, the water flowing from the one opening and the oil from the other. There must be an opening at the high point of each drain to avoid siphoning.

## HOT-WATER TANK AND FLOAT

The arrangement shown is a departure from the ordinary hand-regulated means commonly used in plants for returning hot water to

boilers, in that the float employed is of the open, or bucket, variety, is at all times full of water and is much more powerful than the hollow air-tight ones and not as likely to get out of order. The apparatus consists of a tank about 20 in. in diameter by 25 in. deep, on top of which is fitted a cover secured by bolts to an angle-iron ring riveted around the top of the tank. The open-top bucket is 16 in. in diameter by 10 in. deep and is made of 16-gage metal with the bottom reinforced where the stem is attached. The stem extends through the cover of the tank



RETURN-WATER TANK WITH FLOAT TO CONTROL PUMP

to the valve controlling the steam supply to the pump, as shown. To the bottom of the tank is fitted a guide about 18 in. long, for the lower end of the stem, to keep the float central in the tank. The lever is about 18 in. long and is supported on a fulcrum; the weight is about 20 lb. and is made to be moved along the lever to balance the float and obtain the correct adjustment of water level in the tank.

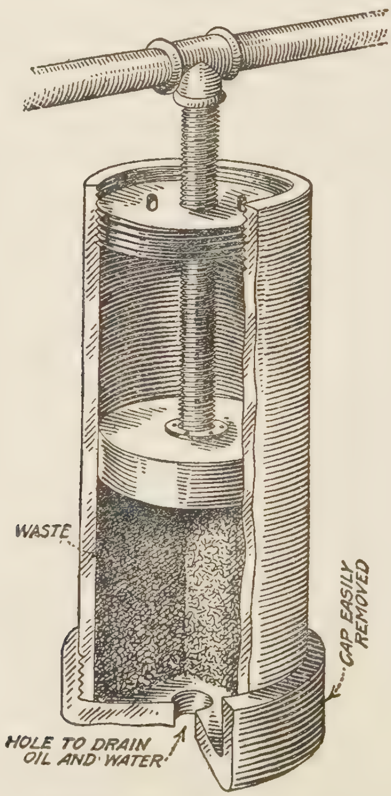
The operation of the apparatus is as follows: When the water flows into the tank, it fills the float until it overflows, and when the water level rises in the tank the counterweight raises the float and opens the regulating valve which admits steam to the pump. With proper ad-

justments the pump will work at a rate of speed depending on the supply of water coming into the tank, which can, of course, be made of any size to suit the quantity of water to be handled. The size described is found suitable in conjunction with a 6 x 4½ x 6-in. duplex pump. The pump must be set at least 12 in. below the tank so that the hot water may flow into it.

This device is quite simple to construct and operate, and water can be collected from any number of sources. It is also powerful and positive in its action. Makeup water can be added in any desired quantity, and it affords a ready means for introducing boiler compound, which can be fed slowly into the tank.

## HOW DIRTY WASTE MAY BE CLEANED

Waste that is used for wiping machinery generally becomes extremely dirty with use and is then thrown on the coal piles. A better way is to collect the waste in a suitable covered can and, when a sufficient quan-




PRESS FOR WASHED WASTE

tity has accumulated, place it in a strong solution of common soda and boil it. A large proportion of the dirt and oil will be removed, and a proper rinsing will make the waste ready for use again. A press for squeezing out the moisture in the waste can be made, as illustrated, from a piece of 5-in. pipe. The pipe is fitted with a drilled cap on one end and a plug on the other, and the plug is tapped for a threaded ½-in. rod fitted with a piston on one end and a tee on the other. The piston can be made of wood. The waste is put in the press and the plug is then screwed into the end of the pipe, and by screwing it on the ½-in. pipe, excess moisture is pressed out. To remove the waste unscrew the cap and force it out by means of the piston.

## MAINTAINING THE ACCURACY OF THERMOMETERS

Notwithstanding the simplicity of thermometers and their widespread use, it will be found that many thermometers are not giving accurate readings for one or more of the following reasons: (1) The wrong type; (2) improperly installed; (3) accumulation of foreign matter on the thermometer well; (4) separation of the mercury in the column; (5) breakage due to careless handling; (6) incorrect adjustment of the reading scale.

It is highly important for good results that a thermometer be selected which has a suitable temperature range. The smaller the range of temperature to be covered the greater the accuracy that can be obtained. For feed water the average range of 50 to 220 or 60 to 240 deg. F. is employed. For condenser service a range of 30 to 160 deg. is usually sufficient. For superheater work the range should be from 200 to 800 deg. For very high temperatures the ordinary mercurial thermometer is unsuited, and some form of pyrometer should be used.

Incorrect readings are common when the thermometer well or bulb does not come in full, constant contact with the liquid or gas being observed. Care should be exercised to see that the bulb or well is placed in a part of the line or tank that is not pocketed or at a dead end. In pipe lines the thermometer should be placed so that the well at all times is fully immersed in the flow. Thermometers placed in tees or elbows are liable to be isolated from the current and give incorrect indications. Care should also be taken to so place the thermometer that it will not be unduly influenced by heat from outside sources. Ordinarily, thermometers are calibrated at living-room temperatures, and if installed in a very hot location, say on a boiler front where the temperature may be 150 or 200 deg., it is obvious that the expansion of the mercury will be greater and cause a higher reading. Thermome-

ters are also subject to error or misadjustment if connected with or to vibrating pipe lines.

In ordinary practice one of the most frequently encountered causes of inaccuracy is the presence of mud, scale, oil or other foreign matter on the well or bulb of the thermometer. In most cases this accumulation cannot be prevented, therefore the thermometer should be removed from its socket from time to time and the well and bulb inspected and cleaned. This feature should be carefully watched where scale is liable to accumulate.

The separation of the thin mercury column often accounts for a high reading. If the mercury column becomes separated, it can usually be reunited by firmly holding the thermometer at the top and giving it a quick jerky throwing movement outward, tending to throw the isolated column toward the well or bulb. Where the column cannot be united in this way, the condition can be remedied by applying heat to the bulb, which will drive the main body of the mercury up the column until it reaches the separated portion, unites with it and carries it back upon cooling.

Most commercial thermometers are supplied with iron or brass cases fitted with a square or hexagonal nut at the base for screwing the instrument into a tapped opening. This nut affords a means of attaching the thermometer without imposing a strain on the instrument itself, but in many cases is overlooked and the body of the case is used, with the result that not infrequently the thin glass tubing is broken. This break often occurs in the base of the thermometer and as some mercury remains in the tube the damage is frequently unnoticed. Where thermometers are installed in exposed places or in open passageways, they should be protected by some sort of shield or guard.

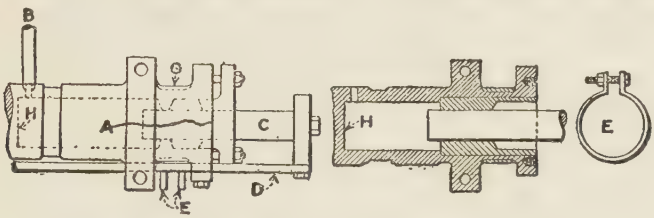
In most thermometers the graduated metal scale is made separate from the tube and hence any movement of either will naturally throw the readings off. The scale is usually provided with a slot and screw to permit adjustment to agree with the calibration. Where any question arises as to calibration, whether a thermometer is correctly adjusted, a simple test of the freezing and the boiling points can be quickly made. The freezing point is readily obtained by packing around the bulb of the thermometer a quantity of finely broken ice in such a manner that while the tube is entirely surrounded by the melting ice, it does not rest in any of the water resulting from the melting. After remaining in the ice pack for five to eight minutes, the location of the mercury column will indicate the freezing or melting point, which is 32 deg. on the Fahrenheit scale. To ascertain the boiling point, the thermometer bulb is placed in a vessel containing boiling water or directly above in

such a manner that it registers the temperature of the steam being liberated to the atmosphere at the boiling point. After holding it in this position for a few minutes the height of the mercury column will indicate the boiling point.

## MAKING A REPAIR TO A CRACKED HYDRAULIC CYLINDER

A crack about ten inches long developed in the cylinder on a retort press, the construction of which is shown in the illustration. The fluid, under 500 lb. pressure, is admitted through the pipe *B* and pushes the ram *C* outward. There is a similar ram in the other end of the cylinder (not shown), and the two are connected by the member *D*, which carries lugs *E*. The cylinders are separated by the wall *H*.

The fracture is shown at *A*, and in due time it opened up to such an extent that the press was useless. The cylinder was removed, placed




CRACKED PORTION OF CYLINDER BUSHED

in a lathe and enough stock bored out to allow about an inch larger diameter than the stuffing box and deep enough to go to the end of the crack *A*.

A bushing was made, the cylinder heated good and hot and the bushing driven into place. When the cylinder was cool, the bushing was bored to a running fit to the ram and counterbored for the stuffing box.

A groove was then turned around the cylinder as shown at *G*, so as to allow room for a draw band under the member *D*. A draw band was made, shaped as shown at *E*, and, while hot, placed around the cylinder and drawn up as tight as possible.

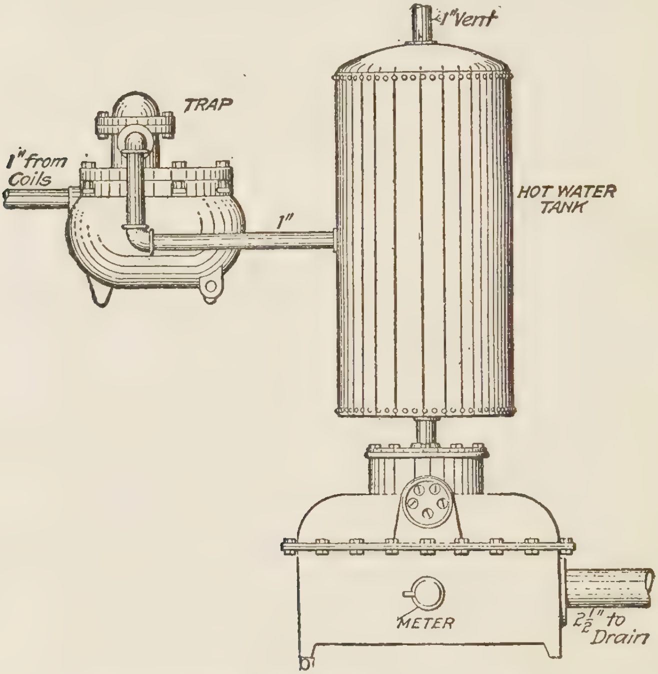
There was a slight leakage at first on account of there being no material available to make the bushing quite long enough to cover the crack past the end, but it soon took up.

## METERED THE CONDENSATION

The illustration shows the method employed for measuring the amount of steam used by several purchasers. This was done by installing several meters with highly satisfactory results to all concerned. The

steam was used in pipe coils for heating and drying in manufacturing processes and was trapped and the condensation was discharged into the sewer.

The traps were of the bucket type, and as the meters are of a gravity flow, nonpressure type, the discharge of the trap was piped to a 12 x 24-in. expansion tank (the kind used in house hot-water heating systems), placing it above the meter, the water flowing from the tank to the meter by gravity. From the top of the expansion tank a vent line was piped, running up about twenty feet and extending outdoors. At




ARRANGEMENT FOR METERING CONDENSATE

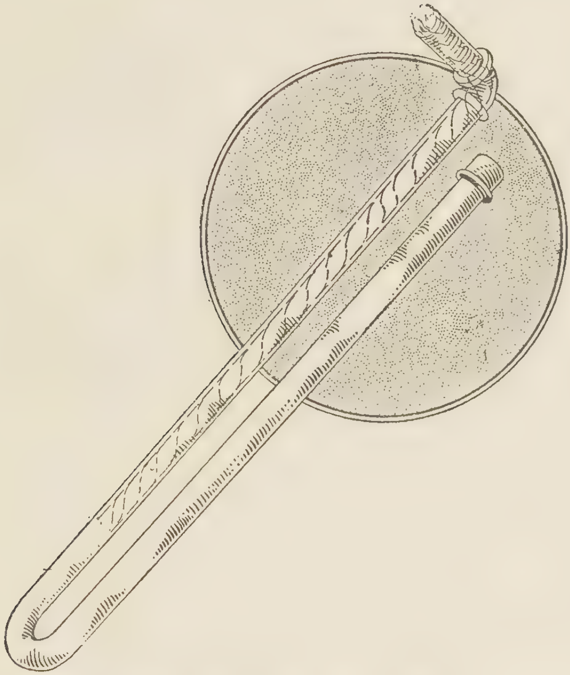
the discharge of the trap this line would relieve all pressure and yet not allow the condensation to escape.

The water flowing through the meter into the drain was recorded in pounds on the dials of the meter and was read monthly, the same as gas or electric meters are read.

## NON-UPSETTING TORCH

The torch shown in the sketch is made from a piece of pipe, any size, threaded and bent as shown, capped at one end and an elbow and nipple screwed on the other end.

Before the cap and elbow are screwed on, cotton wicking is entered by means of a wire and pulled through the pipe until the tail end is about as shown. The projecting end is pulled through the elbow and



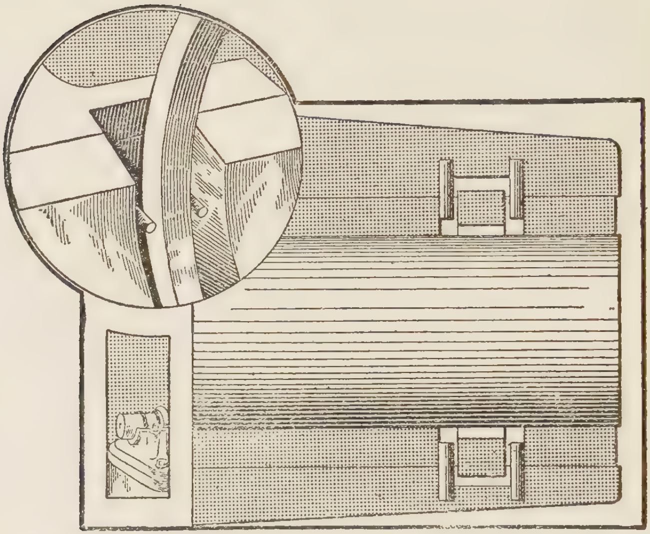
TORCH THAT WILL NOT UPSET

nipple before it is screwed on. Oil is put in at the end *B* and the end capped.

It is impossible to upset the torch, it is easily carried, and it can be hung up by the hook.

## OIL RINGS MAGNETIZED

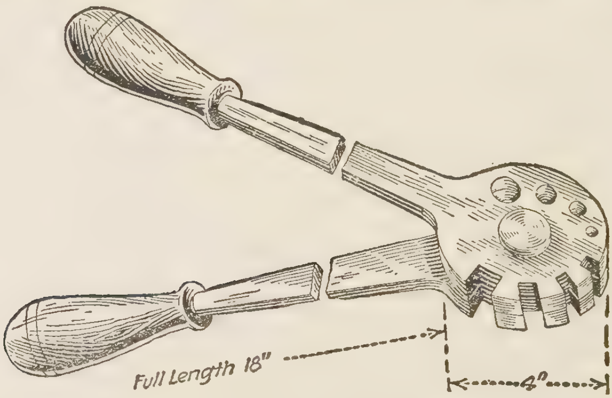
A direct-connected machine had always given more or less trouble at the outboard bearing because the oil rings failed to turn freely, consequently the journal heated. Upon taking this bearing down it was noticed that the box was slightly magnetized—enough to attract the rings, which were steel, against the sides of the slots and keep them from turning as they should. Holes were drilled and brass guide pins put in to keep the rings central in the slots. This prevented further trouble. While this stray magnetism is only small, it is enough to retard the rings considerably and probably stop them at times.



BRASS PINS KEPT RINGS FROM CONTACT WITH BEARING CAP

## A POWERFUL WIRE CUTTER

A handy wire cutter can be made as shown if one is willing to utilize some of his spare time. It is made of $^3/_{16}$-in. tool steel that is first




AN EASILY-MADE WIRE CUTTER

annealed to make it easy to work; then after the tool is finished it is again hardened. The cutter will "bite off" heavy copper or tough steel wire that cannot be cut with either pliers or shears.

## PRESSURE-TEMPERATURE SCALES FOR LOW-PRESSURE STEAM

In the operation of feed-water heaters, condensers and similar apparatus it is often desirable, and sometimes necessary, to know the temperature of vaporization corresponding to a given absolute pressure, or the water-vapor pressure corresponding to a given temperature. The scales given in the figure show the corresponding absolute pressures and temperatures for pressures below atmospheric. The absolute pressure

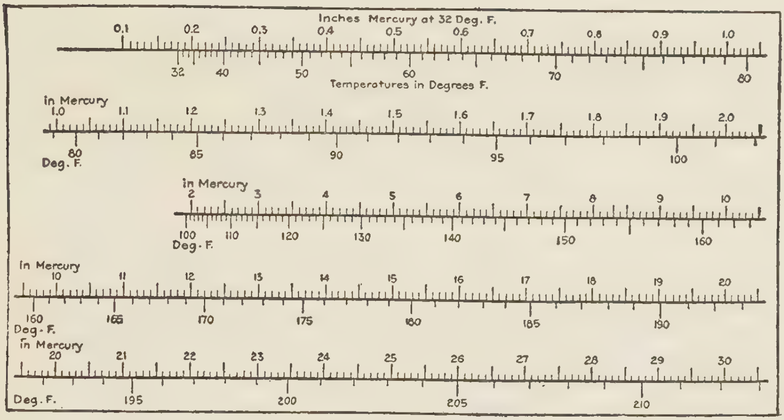


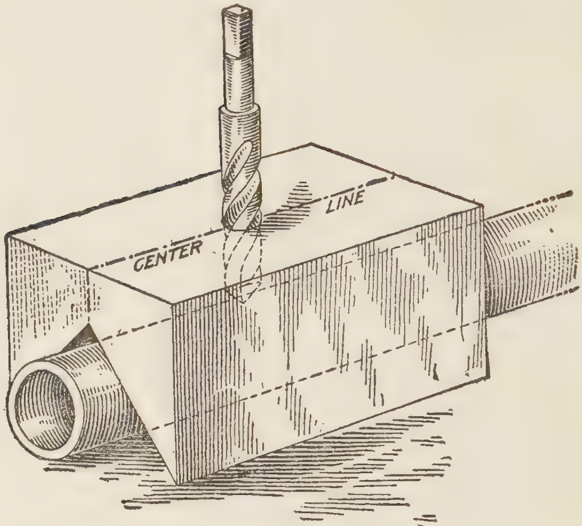

CHART SHOWING VAPORIZATION TEMPERATURE OF STEAM FOR PRESSURES LESS THAN ATMOSPHERIC

is found by subtracting the vacuum-gage reading from the barometer reading, both in inches and mercury.

The two upper scales give the temperatures for each hundredth of an inch pressure from 0.1 in. to 2.0 in. The three lower scales give the values for each tenth of an inch over the range from 2 in. to 30 in.

## PREVENTING A DRILL FROM SLIPPING

In order to drill a hole in a pipe and prevent the drill from slipping, take a block of wood, cut a true V-shaped notch and place it over the pipe. Draw a line through the center of the block corresponding to the bottom of the V and drill a hole on this line. Putting the drill through this hole will bring it on a center line of the pipe and at the same time furnish a support for the drill, thus preventing it from slipping. Pipe of different sizes can be drilled with this same block.




GUIDE FOR PIPE DRILL

## PREVENTING A ROLL OF TAPE FROM UNWINDING

A roll of linen tape is something that must be handled with care when taping a coil, for if it is let fall it will probably result in a tangle. One method of, to a degree, preventing the roll from unwinding so easily is to paint on both sides two strips about one inch wide with

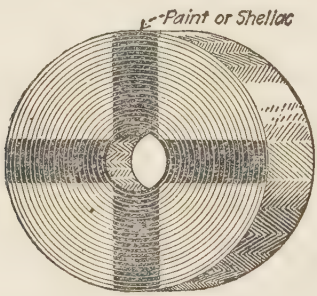



FIG. 1. PAINT OR SHELLAC STRIPS ON ROLL OF TAPE

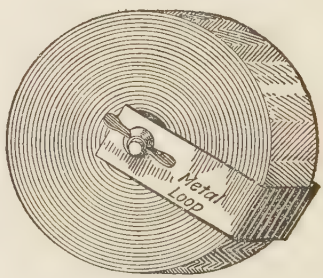



FIG. 2. METAL LOOP IN PLACE ON ROLL OF TAPE

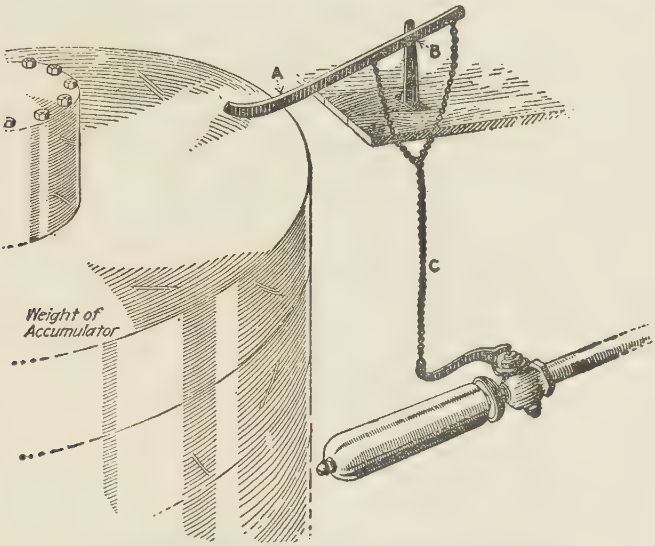
shellac or paint, at right angles to each other, as in Fig. 1. This, however, leaves hard spots on the edges of the tape.

Another method and one that does prevent unrolling of the tape except under tension is shown in Fig. 2. This consists of a loop made of thin spring steel bent so that the ends can be held at the center of

the roll by a bolt. The necessary amount of pressure on the roll to prevent it from unwinding except when the tape is under tension is obtained by tightening the wing-nut until the desired result is obtained.

## REGULATING THE OIL PRESSURE

The step bearings of two vertical turbo-generators were supplied with oil at a pressure of 500 lb., the supply coming from a line under 750 lb. pressure through a reducing valve. An 18-ton dead-weight accumulator connected with the oiling system supplied oil at the required pressure




ACCUMULATOR TRAVEL ALARM WHISTLE

for a few minutes in case the pump in service became airbound, etc., to allow time to put a spare pump into operation.

The oil pressure was regulated by the height of the accumulator, a ¼-in. cable passing over two small pulleys from the accumulator to a weighted lever valve in the steam line to the pump. The arrangement was not satisfactory as the pumps were kept running with a jerky motion due to the action of the valve lever, which caused the accumulator to bob up and down incessantly with the consequent packing wear and leakage around the accumulator shaft.

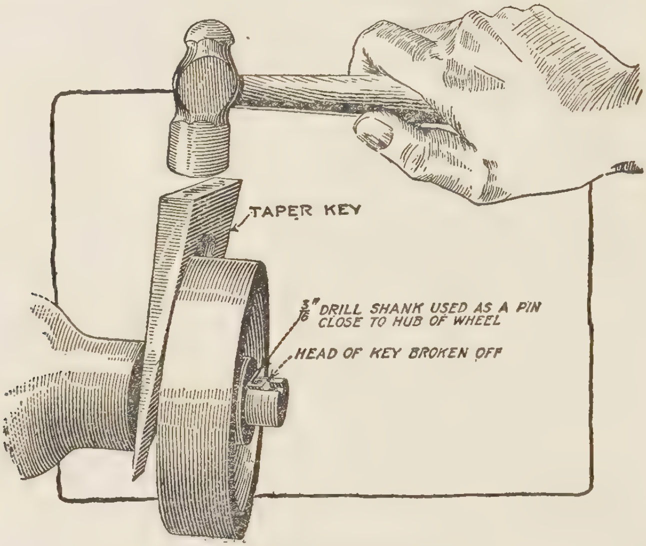
To do away with this trouble, a globe valve was placed in the steam line with a 5-in. pulley fastened to the stem, the face of the pulley being made wide enough to allow several turns of the cable. The free end of the cable was weighted just enough to close the valve.

In case the accumulator rose or fell too far beyond a certain position,

an alarm, as shown in the figure, would be put into operation. The curved lever *A* was pivoted at *B*, the curved end resting on the top weight of the accumulator, the alarm whistle being operated by the chain *C*.

## REMOVING KEY FROM SHAFT

The illustration shows a kink that may be used when removing a pulley fitted with a taper key on which there is no head. The pulley is driven on the shaft as far as possible, and then a small hole (say $^3/_{16}$-in.) is drilled with a breast drill in the end of the key close to the hub of the pulley. A piece of round steel is put in the hole and the

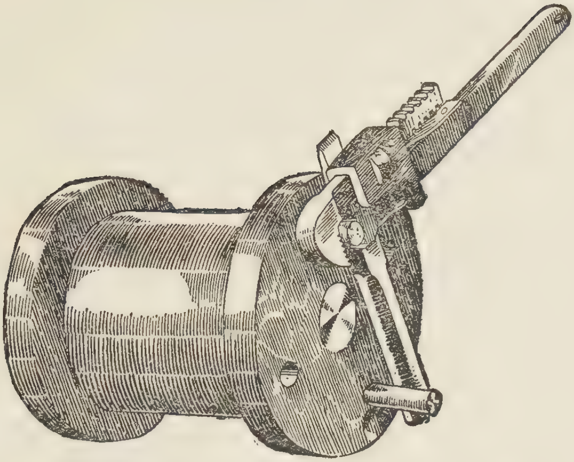



REMOVING A BROKEN KEY

pulley is forced off with the split wedge as shown. All that is required of the pin in the drilled hole is to overcome the friction between the key and the shaft, which is not great if the pulley is not again driven onto the taper.

## REMOVING A TIGHT PIN FROM A CASTING

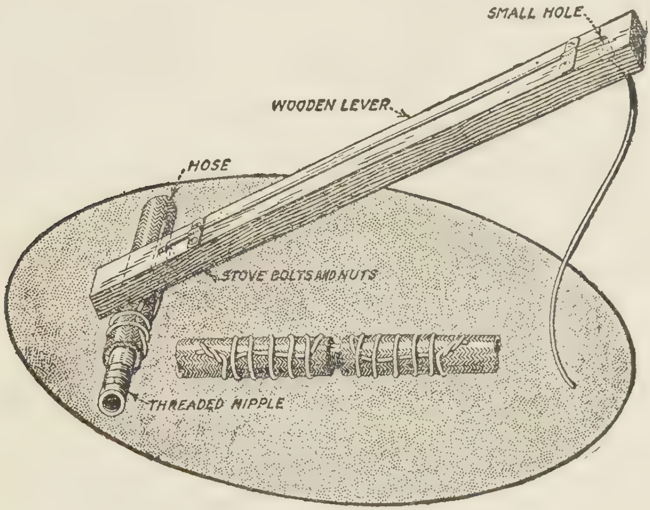
An easy way of removing a tight fitting pin from a casting is by the use of an ordinary stillson or pipe wrench and a cold chisel or wedge. The chisel is placed flat against the casting, and the wrench is applied to the pin in such a way that when the pin is turned, the chisel will act as a wedge or lever and tend to draw the pin out. The method as shown practically explains itself.



ONE WAY OF REMOVING A PIN FROM A CASTING

## REPAIRING HOSE LEAKS

To repair leaks in steam or water hose use a hardwood lever about 2 x 2 x 15 in. long and a ¼-in. hole bored through it at each end, as shown in the illustration. Then about a No. 14 wire is put through




TOOL FOR WIRING HOSE JOINT

these holes and held in place by two metal clips that are attached to the lever by stove bolts and nuts; these hold the wire taut or loose as desired.

The hose to be repaired is cut, at the leak, and a threaded nipple

of the correct diameter is inserted in the hose. Then with the aid of a vise and a pair of pliers a neat joint can be made by using the lever as shown.

## REPAIRING A "NIGGER" CYLINDER

Following is a description of a repair job to a sawmill "nigger" or log canter that had a broken cylinder. A section of an old steam-feed cylinder of the right bore, but six feet long, or one foot too long for the purposes, was found.

Fig. 1 gives an idea of where the break occurred, and Fig. 2 shows how the new cylinder was shortened and provision made for bolting the

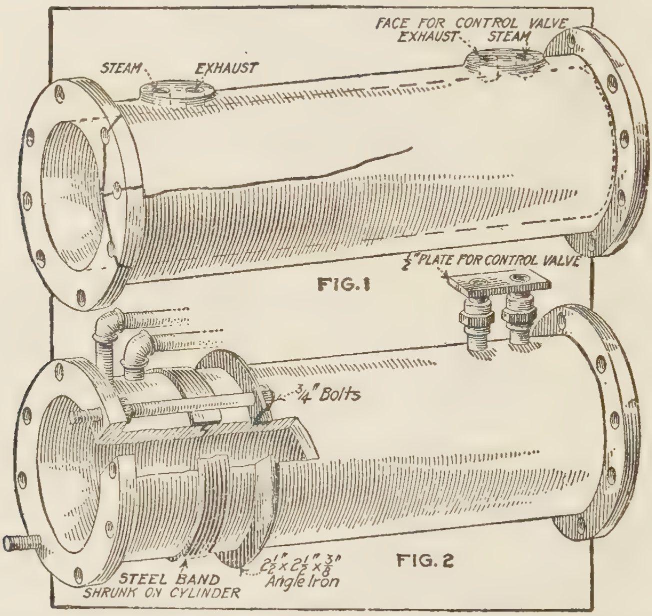


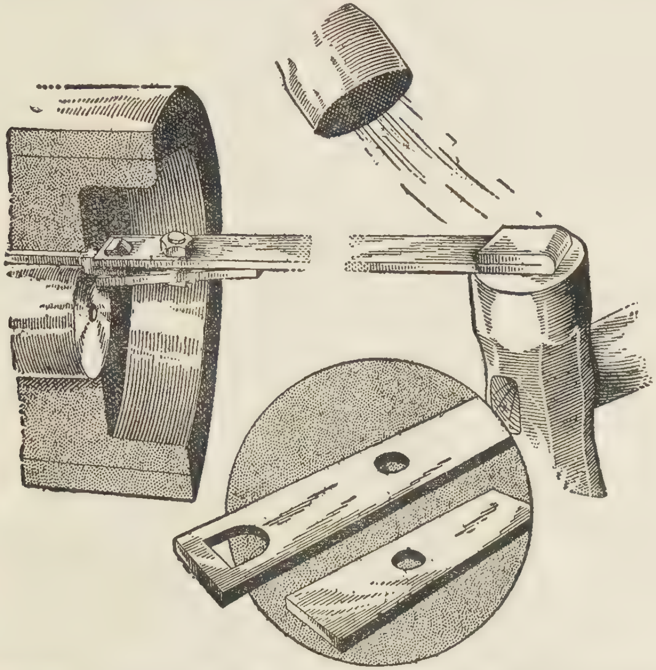

FIG. 1. CRACKED CYLINDER. FIG. 2. HOW NEW CYLINDER WAS SHORTENED AND JOINT REINFORCED

control valve to the cylinder. The top did not require a faced surface, and the piping at the left of Fig. 2 shows how the entering steam and the exhaust were taken care of in the top end of the cylinder, the pipes being coupled to the control valve, which was constructed so as to handle both ends of the cylinder.

## RIG FOR DRAWING KEY FROM PULLEY

The illustration shows a rig used to draw a key that may be in an awkward place to get at. Use a bar ¼ by 2½ in. 3 ft. long, and a

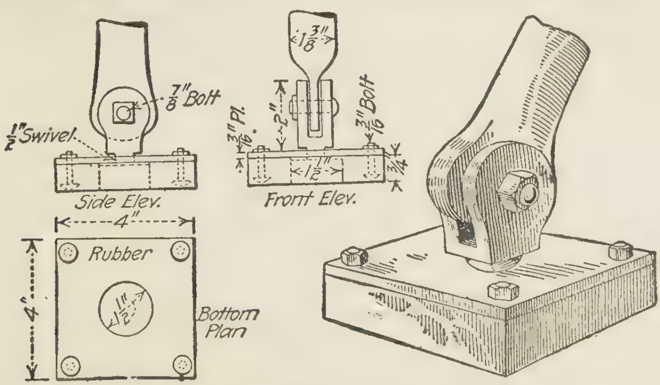
short piece for a clamp. The illustration shows the construction. Several sharp blows with a ten-pound hammer on the end of the bar will generally cause the key to jump out.



EXTENSION CLAMP USED TO DRAW A KEY FROM MOTOR PULLEY

## SAFETY BASE FOR LADDERS

A satisfactory safety base for a ladder that is to be used on cement or iron floors may be constructed from old and soft rubber pump valves or disks. These disks are 5 in. in diameter and ¾ in. thick, with a

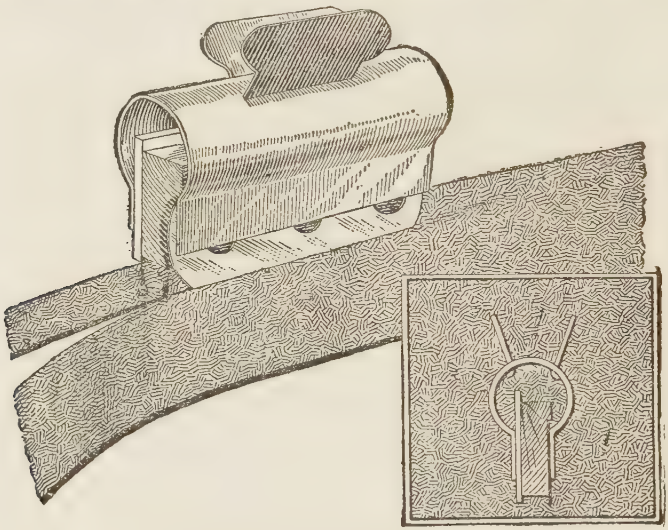



DETAIL OF SAFETY BASE FOR LADDERS

$\frac{3}{4}$-in. circular hole in the center. In making the base, the hole is enlarged to $1\frac{1}{2}$ in. and the disk fastened to a piece of iron plate by means of four small bolts whose heads are countersunk in the rubber. The plate, with its rubber face, is fastened to the ladder by means of a swivel joint. The sketch shows the details of construction. The rubber disk has been trimmed to 4 in. square to make a neater looking job, although the base works just as well when the full-sized disk is used. The swivel joint is made as tight as possible, so that the cavity in the rubber will act as a vacuum cup and will hold securely on wet floors.

## SIMPLE LACING CUTTER

The lacing cutter shown can be made in a few minutes for about five cents, the cost of one strong paper clip. Any make of a safety-razor blade that has become too dull for shaving can be used. If it is



HOME-MADE LACING CUTTER

desired to cut belt lace $\frac{1}{4}$ or $\frac{3}{8}$ in. wide, use a piece of wood of the thickness desired, also have a piece of $\frac{1}{8}$-in. band iron about $1\frac{1}{2}$ in. wide and as long as the blade. Place them as shown, using the iron as a stop and the wood as a gage, and with the razor blade slightly raised at the head end cut the lace.

## SIMPLE TEMPERING METHOD

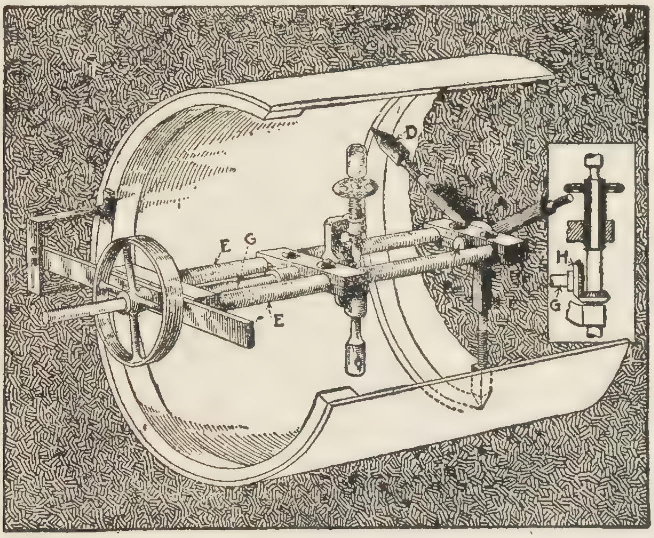
Tempering a drill, cold chisel or other tool properly requires quite a knack, but there is a sure method that requires no skill. First heat

the point of the tool to be tempered to a cherry red and then force it into a bar of lead, keeping it there for about half a minute. Then cool it in water.

To save the temper of a tool, as for instance an ax in which the handle has been broken off and the stub end cannot be easily driven out, drive the cutting edge of the ax into moist ground and then place live coals around the head. When the wood becomes charred, it can be driven out and the temper in the cutting edge will have been preserved.

## A SPECIAL DRILLING DEVICE

The illustration shows a device that has been found of advantage when it is necessary to drill a hole from the inside of a boiler or tank. *A* represents a base piece made with a journal stud *B*. This base piece is provided with a radial arm *C*, with threaded ends and nuts made with conical projecting ends, as shown at *D*. One of these pieces is




DETAILS OF A SPECIAL DRILLING DEVICE

used at each end of the machine, when convenient, for entering and holding the frame. When not convenient to use two of them, one end of the frame is sustained as shown or in some other manner that may suggest itself.

The casting *F* is made of two pieces and is provided with a bearing for the pin *B* and holds the ends of the rods *EE*. The actuating shaft *G* carries the bevel gear *H*, more clearly seen in the figure at the side,

which drives the drill spindle, whose ends are of different lengths for convenience in reaching to different distances. The crosshead may be slid along as required on the rods and the revolving frame and the drill turned around to different positions.

## STRAIGHTENING SHAFTS BY HEAT

Shafts having slight bends can be straightened by pouring hot babbitt against the side that needed to be straightened.

This method can also be used to straighten milling-machine platens which became bent up in the middle of their length, the same as planer platens, because of the peening effect of handling work on their top surface.

The process is the reverse of peening and, like it, is but temporary in its effect. It should be used only to counteract some similar strain.

## STRAINER COVER LIFTER

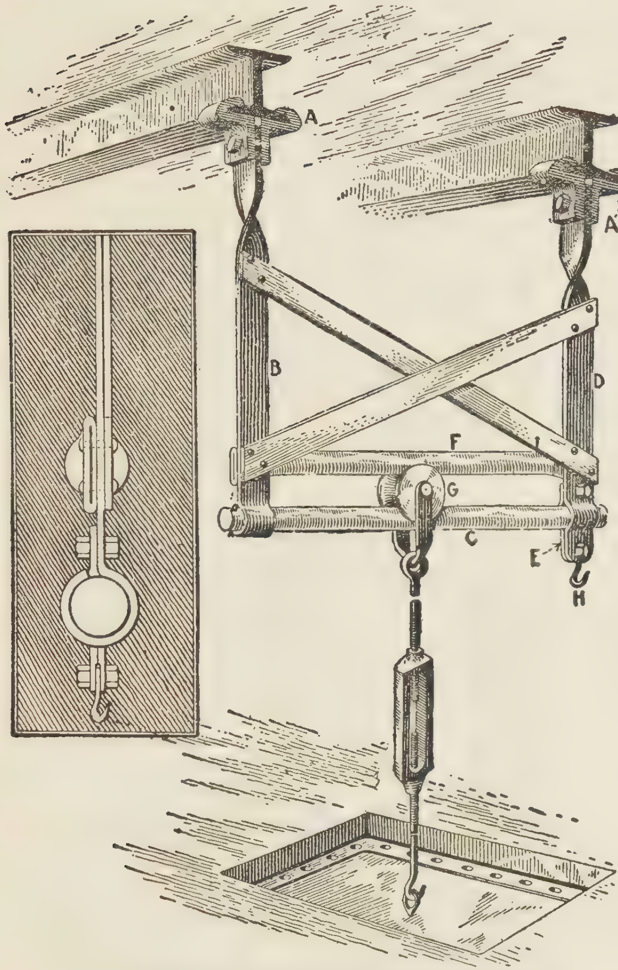
A labor-saving arrangement in the shape of a rig for lifting the cover of a large water-pipe line strainer is shown herewith. By means of this device one man now does the work that formerly required four.

Two iron beams ran parallel along the ceiling of the basement. To each of these beams a two-piece clamp *A* was bolted, the clamping bolt also passing through a hole in one end of a piece of flat iron bar *B* and *D*, bent at a right angle so as to facilitate bolting the crossbars in place.

The lower end of the rod *B* is bent to hold a 2-in. rod *C*. The end of the rod *D* is made in the shape of a bearing, the cap *E* being secured in place by bolts. This supports the other end of the 2-in. rod, on which a roller *G* travels. A 2-in. guide rod *F*, the ends of which are flattened, is bolted to the crossbraces.

From a pin passing through the pulley *G* is hung a U-link, to which one end of a turnbuckle rod is hung. Another turnbuckle rod is made with a hook for engaging an eyebolt that is secured to the center of the strainer cover. At one end of the crane a hook *H* is attached, on which the eyebolt is held when not in use.

When the cover is to be lifted from the strainer, the hook of the turnbuckle is hooked into the cover eyebolt, and after removing the cover nuts the turnbuckle is screwed up enough to clear the cover plates from the studbolts. The roller and cover are then pushed to one end of the rail *C* until the cover is wanted for replacement.




CRANE FOR LIFTING STRAINER COVER

## WIRE SCRAPER MADE FROM HACKSAW BLADE

A handy wire scraper for use around a repair shop and in armature winding can be made from an old twelve-inch hacksaw blade. First grind off the teeth on an emery wheel, then by using two pairs of pliers,

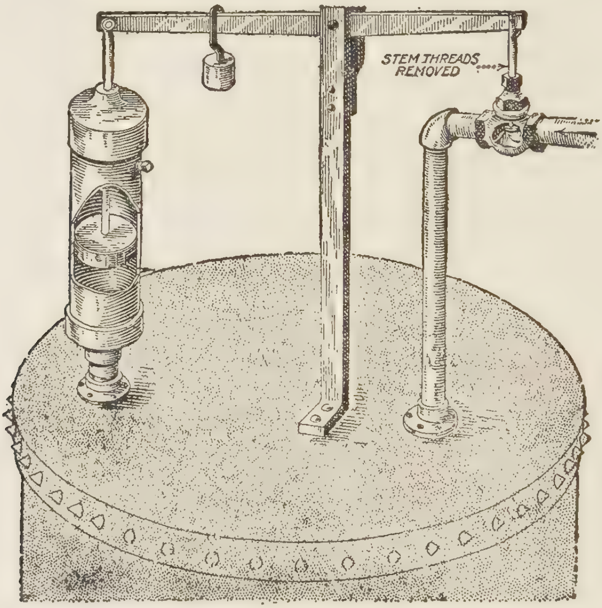
WIRE SCRAPER COMPLETED

hold it in a blowtorch flame and heat to a dull red and bend it in the shape shown. Heat and bend only a small portion at once and do not let it get very hot. Allow the blade to cool slowly and do not put it in water. When in the proper shape and cooled, grind the ends to bevel inwardly as shown.

This tool is handy for scraping solder from old commutator leads or for removing cotton insulation from new leads.

## TANK-PRESSURE REGULATOR

The illustration shows a pressure-regulating rig attached to a tank in which it was desirable to maintain a pressure of about 20 lb. when supplied by a main carrying 80 lb. or more. The illustration makes the construction and operation so obvious that no explanation seems necessary. The pressure within the tank can be varied by the weight on the arm.



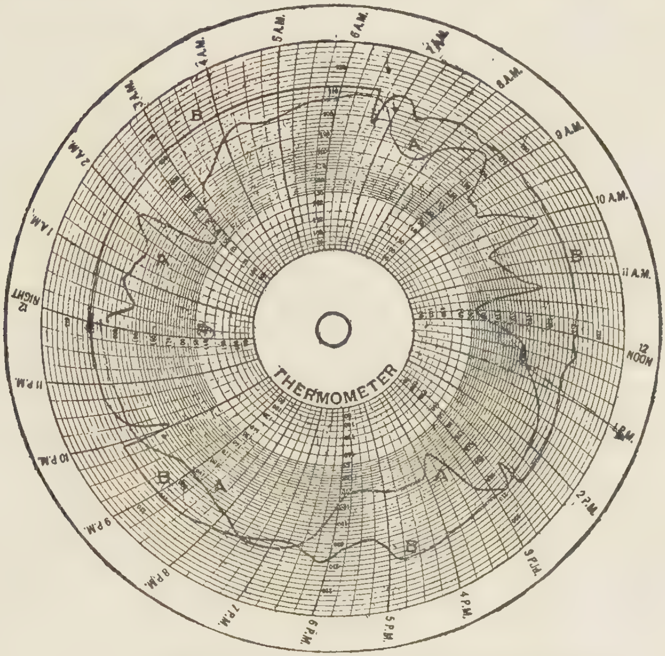

PRESSURE REGULATOR ATTACHED TO TANK

## USING CHARTS OVER AGAIN

The accompanying chart is for the same date of last year and this year where the operating conditions were practically the same, and shows two chart records.

A red line *A* is for Feb. 3, 1919, with an average feed-water temperature of 193 deg. F., and a green line *B* is for Feb. 3, 1920, with an approximate average temperature of 209 deg. F. The operating con-

ditions on both days were practically the same, but on Feb. 3, 1919, 3600 lb. less coal was burned than on the same date last year. The outside temperature on Feb. 3 last year was 22 deg. F.; the average



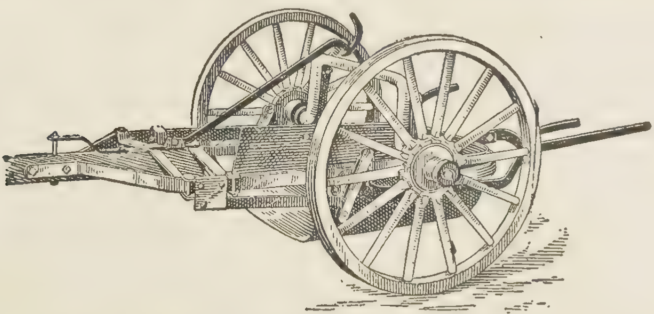

TWO TEMPERATURE RECORDS ON ONE CHART

outside temperature on Feb. 3 this year was 31 deg. F., taking it for the entire 24 hours.

The comparison shows very plainly what a fireman can do.

## TRANSFERRING COAL WITH SCRAPER

When coal is stored at a distance from the boiler room, but no con-

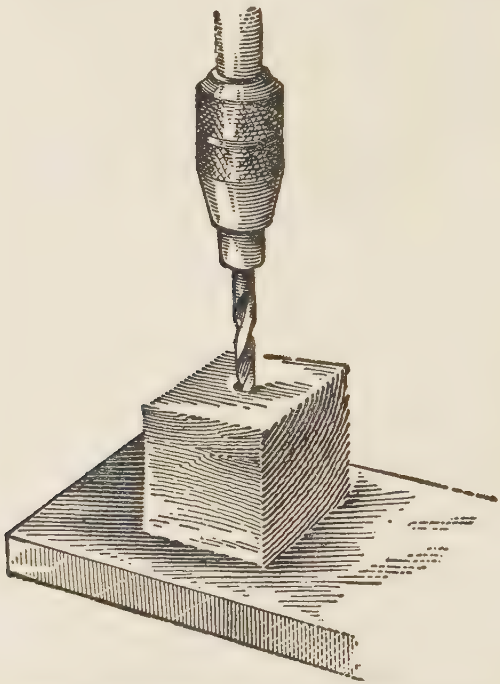


ORDINARY WHEEL SCRAPER FOR TRANSFERRING COAL

veying system installed, it can be readily moved by using a scraper such as is used for moving earth in grading and excavating, using one man and a horse. The scraper of the type shown in the illustration handles about half a cubic yard at a load.

## USING A SMALL TWIST DRILL

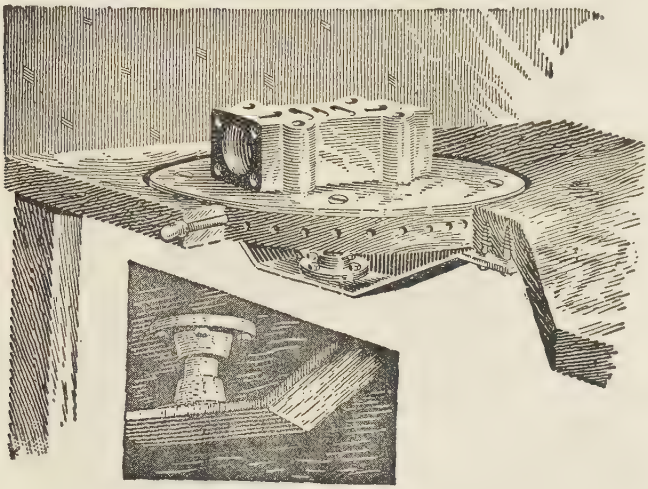
When drilling a hard surface and using a fine drill, there is danger of breaking the drill, especially if it is high-speed and "wabbly" like a portable electric or air drill. To prevent breaking, take a small block of wood as thick as the length of the drill will allow and bore a hole through it the size of the drill or a little larger and place this over the drill. There is much less chance of buckling and breaking.



GUIDE BLOCK TO STEADY DELICATE DRILL

## WORKBENCH TURNTABLE

A simple but useful device for handling heavy castings or machinery parts while doing bench work is a revolving table set in the bench flush



REVOLVING BENCH TABLE

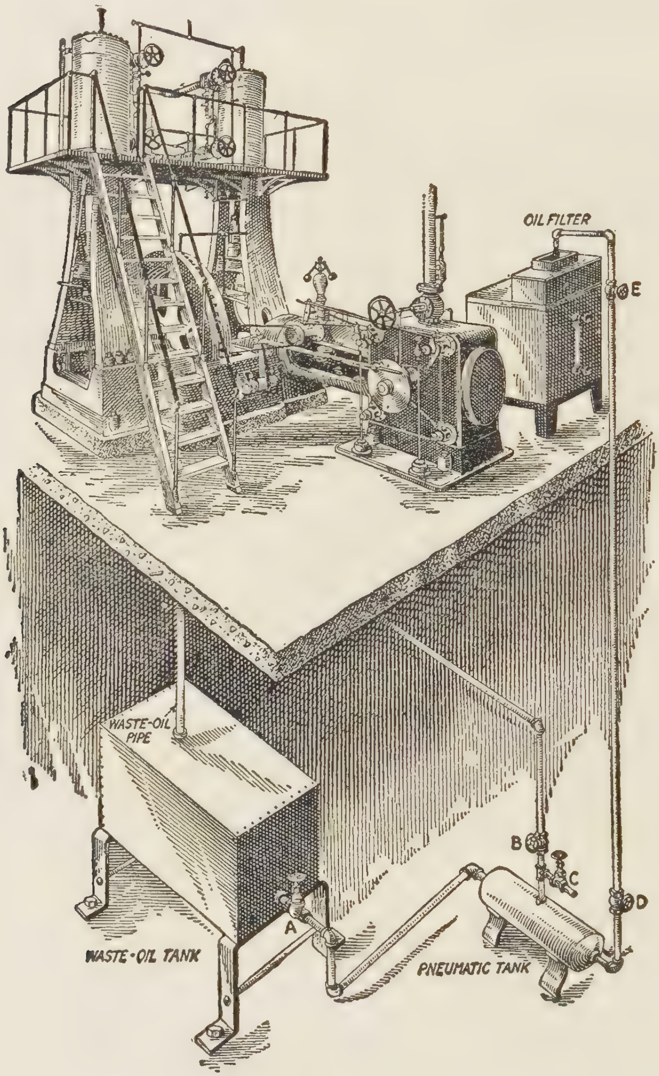
with the top. It is easily made from two large-sized pipe flanges, a nipple and a couple of suitable hangers made of ½ x 1 in. flat stock.

The top of the turntable plank is covered with a piece of ⅛- or ¼-in. plate steel. The idea is conveyed in the sketches. A locking pin is used to hold the table in any desired position.

## OIL HANDLED BY AIR PRESSURE

An easy and cleanly means of handling the otherwise waste oil from engines and other machines is shown. The oil is conducted by suitable drains to a galvanized-iron tank in the basement, from which it is drawn through the valve *A* into the pneumatic tank, which is a 15-gal. heating boiler. The valve *C* is left open to vent the air during the filling processes. After the pneumatic tank is filled, valves *A* and *C* are closed and *B* and *D* opened, air from the compressed-air system being admitted

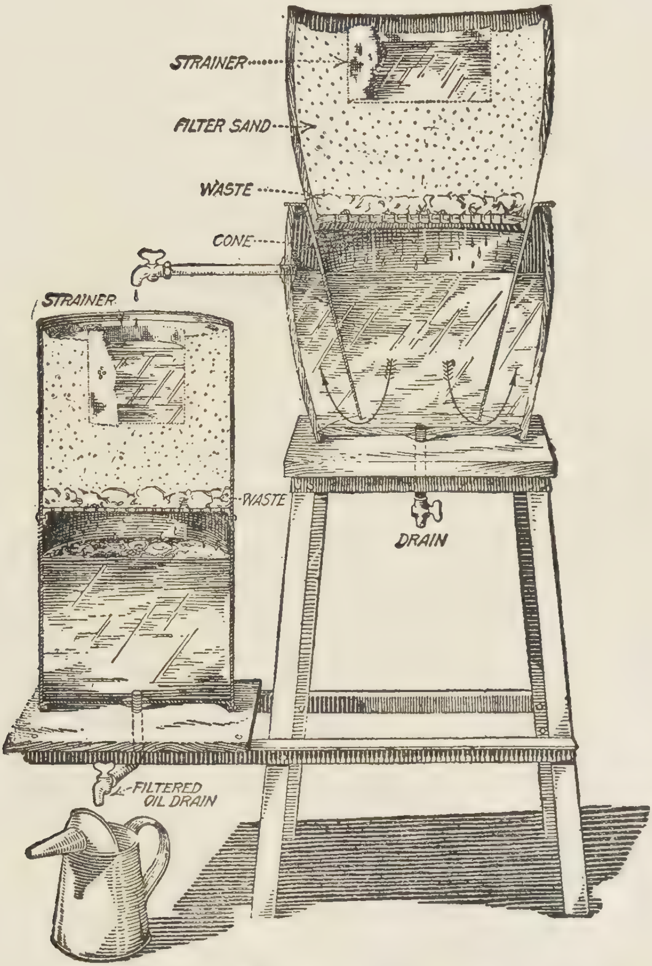
at *B*. By means of the valve *E* the operator regulates the flow of oil to suit the capacity of the filter.




PIPING OF OIL-HANDLING SYSTEM

## SIMPLE OIL FILTER FOR RECLAIMING LUBRICATING OIL

Following is a description of an oil filter that may be used to reclaim lubricating oil that is black with suspended carbon from the drip




SIMPLE HOME-MADE OIL FILTER

pans of oil engines. It is first put into a barrel to settle. After a week's time the oil is skimmed and passed into a sand filter consisting of two oil barrels cut off 6 and 18 in. from the top respectively. Inserted into the lower barrel is a funnel-shaped galvanized iron cone. The top barrel fits into this cone and is filled with sand. Holes are

drilled through the bottom, over which is put a layer of waste to prevent the sand from sifting through with the oil. The sand must be dry, otherwise the oil will not pass through. Embedded in the sand is a round close-mesh strainer into which the used oil is poured. As may be seen from the sketch, the oil passes through the funnel to the bottom of the lower barrel, then rises until it reaches the overflow pipe. This gives some of the suspended matter a chance to settle before the oil is drained off.

From the overflow pipe the oil is passed to the strainer of the bagasse filter, which is made of two old gasoline cans with their tops cut off. The upper one has holes punched in the bottom through which the oil passes. A strip of tin may be soldered to the under side of the upper can to prevent it from sliding off. The upper can also has a layer of waste put over the bottom for the same reason as in the top barrel and is filled with bagasse ash. A fine sand probably will give the same results as bagasse ash where the latter is not obtainable.

A clean and exceedingly clear oil can be drained from the lower can and it will take the place of dynamo oil previously used on the bearings of the machinery of the plant.

The sand around the strainer of the top filter must be renewed about once a month, as it will be saturated with carbon particles, which will prevent the passage of the oil. In doing this, all the sand need not be removed; but only a layer of about two or three inches nearest the strainer.

In first filling the filter with sand or bagasse ash, care should be taken that the sand nearest to the outside walls is well packed, as otherwise the oil may find its way down along the sides.

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